

Mutah University
College of Graduate Studies

The Impact of Applying Production Management Techniques on the Maintenance of Electrical Utilities in the National Electric Power Company

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استكمالاً لمتطلبات الحصول على درجة الماجستير في **الادراة الهندسية.**

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Dedication

To my Parents
The reason of what I become
Thanks for your great support and continuous care.
To my Brother and Sisters
I am really grateful to you
You have been my inspiration, and my soul mates
To my Supervisors
Prof. Salloom A. Al-Jibury
Prof. Omar N. Al-Ma'aitah
To everyone who’s helped me
and supported me to complete this Thesis

I dedicate this thesis

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Thank you for always being there for me.

Mohammad S. A. Al-Ghunimat

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Abbreviations

ATO : Assemble to order
CAM : Computer-Aided Manufacturing
CIM : Computer – integrated manufacturing
CM : Corrective maintenance
COPICS : Communication-Oriented Production Information and Control System
CRP : Capacity requirements planning
ENS : Energy Not Supplied
ETO : Engineer to order
IBM : International Business Machines
IEEE: Institute of Electrical and Electronics Engineers
ISO : International Organization for Standardization
JEA : Jordan electricity authority
KPI's : Key Performance Indices
Ltd : Limited company
MATS : Make and assemble to stock
MPC : Manufacturing planning and control
MPS : Master production schedule
MTO : Make to order
MTS : Make to stock
MV : Medium Voltage
NEPCO : National Electric Power Company
PDCA : Plan-do-check-act
PdM : Predictive Maintenance
PERT : Program Evaluation and Review Technique
PICS : Production Information and Control System
PMC : Plant monitoring and control
PVM : Preventive Maintenance
SAIDI : System Average Interruption Duration Index
SAIFI : System Average Frequency Duration Index)
SPC : Statistical process control
SPSS : Statistical Package for the Social Sciences
TQM : Total Quality Management

Abstract

The Impact of Applying Production Management Techniques on the Maintenance of Electrical Utilities in the National Electric Power Company

Mohammad S. Al-Ghunimat

Mu'tah University, 2015

The increasing in the number of population caused an increased demand on the infrastructure and the services which leads to establish a huge number of projects to face this growth; this increasing in the number of facilities and their complexity required new management techniques to effectively manage it.

This research aimed to know the impact of applying of the production management techniques on the maintenance departments in the national electrical power company, where this research focused on two techniques and they are: Total Quality Management (TQM) and Communication-oriented production information and control systems (COPICS).

Descriptive statistics were used throughout in this research, the study sample included a (97) employee from the employees of maintenance departments in the national electric power company, a questionnaire were formed and distributed on the study sample to find the impact of applying production management techniques on the maintenance of electrical utilities in the company, then SPSS software were used to analyze the data to get the desired results.

The results show that the impact of applying total quality management on the maintenance got an average mean of (2.9542) out of (4) which represent a medium range of impact, the impact of applying communication-oriented production information and control system on the maintenance got an average mean of (2.9101) out of (4) which represent a medium range of impact and the lower values of impact mean are due to the lack of knowledge about total quality management and communication-oriented PICS from the employees.

This study recommends training the employees of maintenance departments on the using of the communication-oriented production information and control systems and applying the total quality management philosophy in the other departments in the national electric power company.

الملخص

أثر تطبيق تقنيات إدارة الإنتاج

على صيانة المرافق الكهربائية في شركة الكهرباء الوطنية

محمد صالح الغنيمات

جامعة مؤتة ، 2015

إن التزايد المستمر في أعداد السكان سبب زيادة في الطلب على البنى التحتية والخدمات مما أدى إلى إنشاء عدد كبير من المشاريع لمواجهة هذا النمو، وهذه الزيادة في عدد المنشآت وتعقيدها يتطلب تقنيات إدارة جديدة لإدارتها بشكل فعال.

هدفت هذا البحث إلى معرفة أثر تطبيق تقنيات إدارة الإنتاج على أداء الصيانة في شركة الكهرباء الوطنية، حيث ركز هذا البحث على تقنيتين من تقنيات إدارة الإنتاج وهما: إدارة الجودة الشاملة (TQM) و معلومات الإنتاج وأنظمة التحكم الموجهة بالحاسوب (COPICS).

تم اتباع المنهج الوصفي لتحقيق أهداف البحث، شملت عينة البحث (97) موظفاً من الموظفين العاملين في دوائر الصيانة في شركة الكهرباء الوطنية ، تم تشكيل استبيان و وزعت على الموظفين لإيجاد أثر تطبيق تقنيات إدارة الإنتاج على صيانة المرافق الكهربائية في الشركة، و تم تحليل البيانات باستخدام برنامج ال SPSS .

أظهرت النتائج أن أثر تطبيق الإدارة الشاملة للجودة على الصيانة على متوسط حسابي (2.9542) من (4)، و يعتبر هذا الأثر ذو درجة متوسطة، حصل أثر تطبيق نظم التحكم و معلومات الإنتاج الموجهة بالحاسوب على الصيانة على متوسط حسابي (2.9101) من (4)، و يعتبر هذا الأثر ذو درجة متوسطة، يرجع انخفاض قيم المتوسط للتأثيرات إلى نقص المعرفة لدى الموظفين في الشركة عن مبادئ إدارة الجودة الشاملة و نماذج نظم التحكم و معلومات الإنتاج الموجهة بالحاسوب. أوصت الدراسة على تدريب الموظفين في أقسام الصيانة على نظم التحكم ومعلومات الإنتاج الموجهة بالحاسوب و تطبيق تقنية إدارة الجودة الشاملة في الدوائر الأخرى في شركة الكهرباء الوطنية.

CHAPTER ONE
INTRODUCTION

1.1 General View

According to the Social Statistics Directorate at the Department of Statistics (2006) the population growth rate in Jordan has been higher than the global average. As a result of this increasing in the population growth rate and due to the events that happened in the neighboring countries that caused of migrations to Jordan, the population size increased.

The rapid growth in the population cause an increasing demand on the infrastructure and the services such as roads, bridges, tunnels, water supply, sewers, electrical grids and telecommunications. (Asoka et. al. 2013), so the countries established a lot of projects to face this rapid growth, for example to face the electrical demand four new power stations were established with a 400 Mw rated generation load and more than eight substations were expanded.(NEPCO,2014)

The rising number of facilities and the increasing of their complexity made it difficult for the traditional management methods to manage them, so the managers and the owners searched for a new management methods to effectively manage their organizations and companies and to achieve their goals and gaining the profit that they want, and they found that the production management methods are the best management methods to face the rising number of facilities and their complexity.

The production management term refer to the side of production system that related to formulating the decisions and the actions necessary to complete the production process in accordance with the productivity Foundation Strategy and achieving the goal represented by increasing the value of the outputs of that process to the value of their inputs. (Gass and Harris, 1996)

It is no longer in front of business organizations, but the trend towards cost restructuring and reduction while maintaining or increasing the level of quality in order to strengthen strategic and increase its market share position and one of these ways which we will use it in this study is the total quality management that helps organizations access to the highest quality in maintenance, leading to lower costs and maximize profits.

The global and local industrial and electrical companies facing many challenges and economic variables and the most important of them is the increased competition among both global and local and the attendant change in the consumer behavior, which has become more aware in consumption and a greater ability for choosing the best service after its adoption the quality as a fundamental criterion in the service selection.

Therefore, this study came to shed the light on the extent to which the national electric power company on the use of production management techniques to improve the maintenance performance carried out by the company.

1.2 Study Variables

This section will give some definitions of the variables that will be used in the hypotheses of this study, and they are:

First: Independent Variables (Production management Methods)

Production management methods are the methods that manage the planning and implementation of the entire production process, from the order of raw materials to delivery to the client (Telsang, 2000)

This study will focus mainly on two production management methods which are:

1- Total Quality Management (TQM).

British Standards Institution (1992) defined Total Quality Management as a management philosophy and company practices that aim to harness the human and material resources of an organization in the most effective way to achieve the objectives of the organization.

2- Communication-Oriented PICS (COPICS)

Communication-oriented production information and control system (COPICS) is a systematic method of performing the technological disciplines of the enterprise, COPICS uses electronic data collection terminals instead of manual forms. (Halevi, 2001)

Second: Dependent Variables (Maintenance)

White (1979) defined maintenance as the "work undertaken to restore every facility to an acceptable standard at an acceptable cost".

The parameters of the Maintenance are:

I. Corrective Maintenance:

Cram101 (2012) defined Corrective maintenance as a maintenance task performed to identify and rectify a fault so that the failed equipment, machine, or asset can be restored to an operational condition within the tolerances or limits established for in-service operations.

Corrective maintenance is maintenance which is carried out after failure detection and is aimed at restoring an asset to a condition in which it can perform its intended function. (Mahmoudi, El Barkany, El Khalfi, 2014)

II. Predictive Maintenance:

Many research defined Predictive maintenance, some of these definitions are:

1- "Predictive maintenance a philosophy that uses the actual operating conditions of plant equipment and systems to optimize total plant operation." (Mobley, 2002)
2- "Predictive maintenance is what its name implies: Maintaining resources and machines, whether large or small, according to fact-based expectations for when they will fail or require service." (Negandhi, et al., 2015)

III. Preventive Maintenance

Preventive maintenance conclude all operations that are related to the routine detection on the machines and equipment and inspect them and doing the needed corrective actions to maintain their productivity, and the most important Character of it is the Regular and systematic operations, which include the inspection and testing of machines and instruments. (Reda, Husian, 2000).

1.3 Problem Statement

Production management methods are from the most leading concepts that captured the widespread interest by researchers and practitioners of management such as Al-Shawawreh and Al-Mutairi (2010) and Mwacharo (2013), and it consider treasure for the organizations looking for raising their productivity and improving production quality and reducing costs, and for the important of these methods and their impact on the organizations specially those organizations that the other organizations depending on their services .

Through the informed researcher and his relevance with maintenance department in the national electricity power company, he noticed that there are a lot of managerial behaviors that there is no need for them or do not add value for maintenance and they must be re-studied to increase the effectiveness of maintenance because of the proper and effective maintenance plays a big role in the success of the company in doing their works with high efficiency and the required quality.

The problem of this study focusing on determining the successful implementation of the production management methods in improving the maintenance performance in the national electrical power company, so the problem of this study will be concentrated in the following question: what is the impact of applying production management techniques on the maintenance of electrical utilities in the national electricity power company?

1.4 Significance of Study

The importance of this study comes from the rising importance of using the production management techniques in the companies today for the performing their daily works, and this has a clear effect in the workflow line in the companies and in effectively achieving their goals and in their growing capabilities on performing the activities, so this study is gaining their importance from being:

1- Showing one of the important variables in the administrative development and improve the level of maintenance which are the production management techniques and their effect in improving the maintenance level in the companies, which consider one of the important and modern topics.
2- This study also derives its importance from being will contribute to draw the attention of the managers and the decision-makers in the national electricity company to how is the best use of the production management techniques and to use them for helping to improve the level of maintenance and increase efficiency and provide the best service and get rid of the waste of resources.
3- This study from the academic side may be one of the few studies on this topic in the Jordanian companies by the knowledge of the researcher, for that it is consider an academic starting point to rely on it in studies later.

1.5 Research Objectives

This research mainly aims to know the level of using of production management techniques and their impact on improving the maintenance of electrical utilities in the national electrical power company, and there are secondary objectives which are represented as:

1- Determine the impact of applying Total quality management on the corrective maintenance in the company.
2- Determine the impact of applying communication-oriented production information and control system on the corrective maintenance in the company.
3- Determine the impact of applying Total quality management on the Predictive maintenance in the company.
4- Determine the impact of applying communication-oriented production information and control system on the predictive maintenance in the company.
5- Determine the impact of applying the Total quality management on the preventive maintenance in the company.

6- Determine the impact of applying communication-oriented production information and control system on the preventive maintenance in the company.

1.6 Research Questions

This study is trying to achieve their goals by answering the following Questions:

1- What are the Concept of Total Quality Management (TQM) and their development?

2- What are the concept of communication -oriented PCIS and their development?

3- What are the elements of Total Quality Management (TQM) that can be applied in the maintenance of electrical utilities in the company?

4- What are the Elements of Communication-Oriented PCIS that can be applied in the Maintenance of Electrical Utilities in the Company?

5- What are the main obstacles to applying Total Quality Management (TQM) in the Maintenance of Electrical Utilities in the Company?

6- What are the main obstacles to applying Communication -Oriented PCIS in the Maintenance of Electrical Utilities in the Company?

7- What is the impact of applying total quality management on the maintenance of Electrical Utilities in the company?

8- What is the impact of applying principle of communication-oriented PCIS (COPICS) on the maintenance of Electrical Utilities in the company?

9- What is the impact of applying production management techniques on the maintenance of electrical utilities in the national power company?

1.7 Research Hypothesis

The main hypothesis of this study is:

H0: There is no impact with statistically significant relationship between the production Management Techniques and the maintenance in the national electricity power company.

H1: there is an impact with statistical significant relationship between the production Management Techniques and the maintenance in the national electricity power company.

And the branches of this hypothesis are the following hypothesizes:

1- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Corrective Maintenance).
   H1: There is an impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Corrective Maintenance).
2- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Communication-oriented PCIS) to improve the level of maintenance dimension (Corrective Maintenance).
   H1: There is an impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Communication-oriented PCIS) to improve the level of maintenance dimension (Corrective Maintenance).
3- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Predictive Maintenance).
   H1: There is an impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Predictive Maintenance).
4- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Communication -oriented PCIS) to improve the level of maintenance dimension (Predictive Maintenance).
   H1: There is an impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Communication -oriented PCIS) to improve the level of maintenance dimension (Predictive Maintenance).
5- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Preventive Maintenance).
   H1: There is an impact with a statistical significant at the level of significance (α≤0.05) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Preventive Maintenance).
6- H0: There is no impact with a statistical significant at the level of significance (α≤0.05) of using production management

technique (Communication -oriented PCIS) to improve the level of maintenance dimension (Preventive Maintenance).

H1: There is an impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (Communication -oriented PCIS) to improve the level of maintenance dimension (Preventive Maintenance).

1.8 Research Model

This Research consists of two kinds of Variables, which are:

1- The Independent Variables which are the Production Management Techniques, where researchers choose two Techniques and they are :

1- Total Quality Management (TQM).
2- Communication -Oriented PCIS (COPCIS).

Based on the Reference of Halevi (2001).

2- The Dependent Variable which are Maintenance of Electrical Utilities ,which is consist of sub variables of :

3- Corrective Maintenance (CM).
4- Preventive Maintenance (PVM).
5- Predictive Maintenance (PDM).

Based on the Reference of Marquez (2007).

According to these Variables, we can construct the module of this research as shown in figure (1.1), which shows the relationship between the independent and dependent variables.

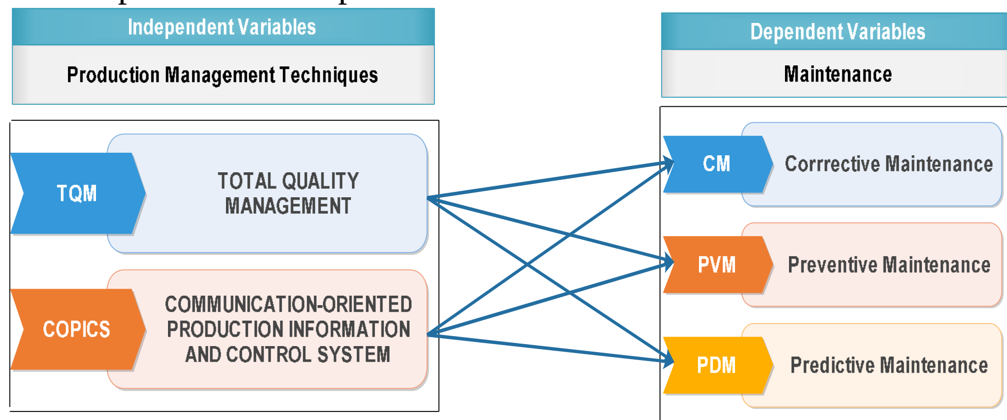


Fig 1.1
Research Model

1.9 Research Methodology

Previously have been mentioned the objectives of this study and the importance of this study, but in this part going to determine how to implement this study and achieved their goals in order to clarify their results, this will be done through the design of a questionnaire directed to a

specific class of society which are the workers and employee in the National Electric Power Company (NEPCO) in the Kingdom of Jordan, then will use the SPSS software to analyze the date to obtain the required results.

1.10 Study Population

The population of this study will be the workers and the employee in the National Electrical Power Company in the kingdom of Jordan who are working in the maintenance sections and they will be in various functions such as technical persons, supervisors, engineers and head of sections.

Chapter Two
Theoretical Framework and Literature Review

2.1 Introduction

Organizations usually suffers, especially those in the developing countries of a big problem in the enlarged numbers of components and the cost of management , retention and their maintenance , which invited them to put several methods to control it in order to reduce industrial costs, and raise the level of profitability.

2.2 Production Management Techniques

For over than two hundred years, the production management has been recognized as an important factor in the economic growth of countries. The old view of manufacturing management started in the eighteen century by Adam Smith who recognized the economic benefits of expert labor, he suggested breaking the works into sub works and recognizing workers to specialized works in which they would become highly skilled and efficient, after that F.W. Taylor implemented the theories of Smith and developed scientific management. (Shah, et.al, 2012).

Many techniques were developed, brief information about the contributions to production management is shown in the table (2.1)

Table 2.1
Historical summary of Production Management (Kumar and Suresh, 2006)

Date	Contribution	Contributor
1776	Specialization of labour in manufacturing	Adam Smith
1799	Interchangeable parts, cost accounting	Eli Whitney and others
1832	Division of labour by skill; assignment of jobs by skill; basics of time study	Eli Whitney and others
1900	Scientific management time study and work study developed; dividing planning and doing of work	Frederick W. Taylor
1900	Motion of study of jobs	Frank B. Gilbreth
1901	Scheduling techniques for employees, machines jobs in manufacturing	Henry L. Gantt
1915	Economic lot sizes for inventory control	F.W. Harris
1927	Human relations; the Hawthorne studies	Elton Mayo
1931	Statistical inference applied to product quality: quality control charts	W.A. Shewart
1935	Statistical sampling applied to quality control: inspection sampling plans	H.F. Dodge & H.G. Roming
1940	Operations research applications in World War II	P.M. Blacker and others.
1946	Digital computer	John Mauchlly and J.P. Eckert
1947	Linear programming	G.B. Dantzig, Williams & others
1950	Mathematical programming, on-linear and stochastic processes	A. Charnes, W.W. Cooper & others
1951	Commercial digital computer: large-scale computations available.	Sperry Univac
1961	Organizational behavior: continued study of people at work	L. Cummings, L. Porter
1970	Integrating operations into overall strategy and policy Computer applications to manufacturing, Scheduling and control, Material requirement planning (MRP)	W. Skinner J. Orlicky and G. Wright
1980	Quality and productivity applications from Japan: robotics, CAD-CAM	W.E. Deming and J. Juran.

2.3 Total Quality Management (TQM)

The concept of quality control is quite old, nowadays Total Quality Management (TQM) has drawn the world wide attention and is being undertaken in different organizations – both profit as well as non-profit. It is now being adopted as a management philosophy.

Some of the important definitions of TQM are as below:

1- "Total Quality Management (TQM) is an approach to improving the effectiveness and flexibility of business as a whole. It is essentially a way of organizing and involving the whole organization, every department every activity, every single person at every level." (Oakland,1989)

2- "TQM is a management system, not a series of programs; it is a system that puts customer satisfaction before profit. It is a system that comprises a set of integrated philosophies, tools and processes used to accomplish business

objectives by creating delighted customers and happy employees. ".(Price and Chell,1993)

3- "TQM is the systematic analysis, but the focus is turning from a process driven by external controls through procedure compliance and enhancement to a process of habitual improvement where control is embedded within and is driven by the culture of the organization."
(Foster and Whittle, 1989)

Successful implementation of Total Quality Management involves both technical and people aspects that cover the layout of the organization and extend to relationships with customers, the analysis of Total Quality Management Models the existing of some elements or principles for the Total Quality Management that are able to be applied in the maintenance in general and in electrical utilities maintenance in special, and from the most important principles are: Khashoggi (2003)

1- Awareness of the concept of total quality management (TQM)

The Total Quality Management starts by realization of the total Quality Management concept by considering it as a goal that can be measured and the top administrative level for the construction that apply Total Quality Management tend to make a various changes in the humanity relationships , communication methods .(Kanji,1996)

2- Top management support and their conviction of TQM philosophy

Getting the tangible support from all administrative level consider from the most important characteristic of Total Quality Management, where the top management convention in the total quality management philosophy create a positive conditions that make the individuals do their jobs according to the standards that their leaders set .(Lawrence,1993)

3- Customer Satisfaction

The successful standard for any facility or organization that offers their services or product for the customers is the customers satisfaction on these services or products, depending on this point total quality management concentrate on the necessary of achieving requirement and forecasting of their customers and the to plan for the future requirement too, because not achieving these requirement consider a failure of the organization itself. (Bestertfield, et.al, 2012)

4- Employee involvement

The experts in total quality management see this involvement as a primary principle of total quality management principles, and they see that each person in the organization must involve in the products and services supplement with high quality and lowest cost, total quality management required a high level involvement from all individuals working in various administrative level, where the top management react for any positive suggestions from workers. (Coyle and Jacqueline, 1999)

5- Work Groups Forming

The top management concern in forming work groups from individuals who have skills and the abilities necessary for problem repairing to improve the type and quality of produced products and services, and those need training to improve their powers.

6- Workers Training

Training is consider one of the basics that total quality management program depend on it, to enable workers of successfully participate in improving quality of products and services, and to perform in a special form that will lead to reduce errors and money waste, and it the most importance and the best available way to give skills, knowledge, and behaviors to the workers that they need to perform their jobs in quality and mastery. (Alkhalaf, 1993)

7- Continuous Improvement

Total Quality Management program depends on the continuous development efforts, and Total Quality Management manager believes that the improving opportunity doesn’t finish no matter how efficient and effective it reached and the quality level that achieve the wishes and expectations of recipients is always changeable so the produced products and services quality are subject to continuous improvement and development without stopping.

8- Prevention of errors

The prevention from errors before it happen consider an important issue in the total quality management program, and this principle need to use an acceptable standards to measure the quality of products and services during the production process instead of using similar standards after the errors happened, the worker must Commit in the quality measurement standards and the correct procedure from the first time where supplying the customers with services and products which have a high quality that get the customers satisfaction. (Alkholy and Alboreny, 1993)

9- Information System and Data Collection

The good information system consider from the most agents that help to successful implementation of the Total Quality Management, this came from the point that the information system is an important element the organization performing their jobs to reach to their goals ,this depends on the available of an effective information system that collect the data in a regular form and analysis it in a form that allow to monitor the processes continuously which will lead the organization to continuous improvement in their performance and to competition. (Huther, 1993)

2.4 Total Quality Management Tools

The following are some of the most common TQM tools in use today. Each is used for, and identifies, specific information in a specific manner. It should be noted that tools should be used in conjunction with

other tools to understand the full scope of the issue being analyzed or illustrated Melsa(1999):

1- Poke-A-Yoke: This concept of the Japanese management philosophy is derived from two Japanese words which are Avoiding (YOKERU) and inadvertent errors (POKA), the main aim of it is to make a process foolproof. The idea is to design the process in such a way that it is self checking or incorporates process steps that cause immediate detection and possible correction of any defect. (Land , Smith and Walz, 2008)
2- Statistical Tools: One of important contributions to the quality was the introduction of statistically approaches to the analysis of defects. Without the use of these tools, one can often make a lot of wrong decisions regarding the cause of a problem. Included in this set of tools are statistical process control (SPC) charts, Pareto Charts, and histograms.(Sage and Rouse, 2009)
3- Force Field Analysis: This tool asks one to diagram the forces (policies, culture, and so forth) that are resisting a desired change and the forces that support the change. This assists one in clearly determining the degree of difficulty of making change and exactly where effort will be needed. The supporting forces are places where assistance can be expected. (Lewis,2001)
4- Root Cause Analysis (Five Whys): it was invented in Japan. It consists of asking a group of questions (whys) until one finds the root cause of a failure product. The objective is to determine why a failure product was produced; this is instead of just fixing the defective product or replacing it. (Brassard, 1989)
5- Fishbone Diagram (Ishakawa Diagram): This tool is also called a cause-and effect diagram. It is used in a brainstorming session to find elements that may affect a given situation or outcome. The causes are often put in groups such as people, material, method or process, and equipment. The resulting diagram takes the shape of a fishbone. (Knapp,2014)
6- The Plan-Do-Check-Act (PDCA) Cycle: This tool is also known as the Shewhart Cycle because it was developed by Walter Shewhart. Deming popularized it in Japan; as a result the Japanese refer to it as the Deming Cycle. The tool shows a new plan for change. It carries out tests to make the change on a small scale, observes the effects, and finally, studies the results to determine what has been learned. The cycle is repeated as needed. (Christensen، Coombes-Betz and Stein, 2007)
7- Affinity Diagram: The affinity diagram is an improvement tool used to organize large amounts of non-quantitative (ideas, opinions, issues, etc.) information into groups based on natural relationships between the items to understand the problem and the lead to solution .It is largely a creative rather than a logical process. (Basu,2004)

8- Interrelation Digraph: This tool takes complex, multi-variable problems, or desired outcomes, and explores and displays all of the interrelated factors involved. It graphically shows the logical and often causal relationship between factors. It's an analysis tool that helps the team members to find logical cause and effect relationships between ideas.(Rumane,2013)
9- Tree Diagram: it's a graphical representation of different levels of actions used to systematically map out, in increasing detail, the full range of paths and tasks that need to be accomplished to achieve a primary goal and every related sub goal. The purpose of making a tree diagram is to evaluate the most specific level of actions items that can be implemented to achieve specific goals. (Stamatis, 1998)
10- Prioritization Matrices: Prioritization matrices are used to evaluate large lists of alternatives of tasks, issues, or possible actions then prioritize it based on the basis of agreed upon criteria. While these tools cannot make decisions, they can help to ensure that all factors are evaluated and that logical decisions are reached. (Harrington and Mignosa, 2015)
11- Activity Network Diagram: it's a control tool to determine and monitor the most efficient path which call critical path .This class of tools includes a wide range of project management tools used to plan the most appropriate schedule for a complex project. Typical examples are Gantt Charts and PERT charts. Several excellent computer programs exist for automating the work associated with this class of tools. (Basu,2004)

2.5 Benefits of Total Quality Management (TQM)

The importance of quality management is to achieve the overall goal of its existence, as it seeks to establish and support, document and preserve the continuation of practical evidence to prove the existence of a number of ongoing programs include effective mechanisms to detect problems and try to find solutions to them, as well as the investigation of the problems that are likely to arise in the future, which could have an impact on the working system and the desired results.

Although the senior management in any establishment is responsible - in the first place - for quality and identify ways and scientific means to apply, where they are by virtue of their positions at the facility officials towards customers, employees, suppliers and shareholders for the success of the enterprise for which they are managed, but it is known that one of the basic assumptions built the application of quality programs lies in the idea that the implementation of this type of program is the responsibility of all employees and staff at all levels and senior management is not important or only quality program coordinator. Therefore, encourage employees at all

levels of various specializations for training on the principles and concepts of quality will help in determining the appropriate action in order to improve quality.

In general, the quality management provides tangible and intangible benefits for both service providers and beneficiaries alike, Alsaqqaf (1998) defined some of these benefits and they are:

1- Creating an environment that supports and maintains continuous development.
2- The involvement of all employees in development.
3- Reduce the tasks and activities necessary to transform inputs (raw materials) to products or services of value to customers.
4- Create a culture strongly focused on customers.
5- Improving the quality of output.
6- Improving profitability and productivity.
7- Learn to make decisions based on facts not emotions.
8- Reduce useless tasks and repetitive work time.
9- Improve the confidence and the performance of work for employees.
10- Increase the ability to attract customers and reduce complaints.
11- Increase efficiency by increasing cooperation between the departments and encourage teamwork.
12- Staff training on the method of processes development.

2.6 Communication-Oriented PCIS (COPCIS)

IBM Developed communications oriented production information and control system (COPICS) in 1972 which was concerned with computer – integrated manufacturing (CIM) seeking a management oriented system by data communication using of computers, display terminals and shop floor terminals in online, real time mode. (Sheikh, 2014)

Communication-Oriented production control system is a group of definitions that determine an approach to an integrated Computer-based production control system. It's a modular approach each module perform an independent application package and all packages are connected to each other using the databases. (Lind, 1991)

Halevi (2001) defined the Communication -Oriented production information and control system (COPICS) as methodic of doing the technology branches of the enterprise by broken it into a number of modules each has a unique function.

2.7 Functions involved in COPICS

COPICS like other Concepts with the objectives of approach adopting the most recent advances in computer technology which provides fast data communication between the user and the computer and ability of

storing a huge amount of data volumes and a variety to present these data easily.

Hitomi (1996) determined functions of COPICS and they are:

1- Engineering and production data control

They are the information which are necessary for production control, and can be a base of planning and governing works, such as:

a) Coordinating data acquisition
b) Structuring the bill of materials by the bill of material processor
c) Controlling engineering change
d) Tracing location and status of engineering drawings
e) Maintaining and creating technical documents
f) Applying CAD to product design

2- Customer order servicing

The main function of Customer order servicing is to take care of customers needs by providing a high quality service and assistance before, during, and after the customer's requirement met. Some of these functions are:

a) Identifying the customer and the product ordered and pricing of the products
b) Checking whether requested due date is met or not
c) Controlling unshipped orders
d) Processing order information
e) Monitoring status of open quotations

3- Forecasting

The basic functions include:

a) Conditioning historical data
b) Selecting the forecast model to fit consistent demand pattern
c) Projecting future demands
d) Applying life cycle curves to modify long range projections and improve the forecast accuracy
e) Correcting the forecast by human judgment

4- Master production schedule planning

The master production schedule (MPS) is effectively the plan that the company has developed for production, staffing, inventory, human resources. The basic steps are:

a) Creating a net change
b) Calculating the net change to the machine load
c) Modifying the plan by examining overload

5- Inventory management

Inventory management is the supervision of units flowing into and out of an existing inventory. This provides two major functions:

a) Inventory accounting
b) Inventory planning and control

6- Manufacturing activity planning

The manufacturing planning and control (MPC) system is aiming with planning and controlling all elements of manufacturing, such as managing materials, scheduling machines and people, and coordinating suppliers and key customers. It deals with three major functions:

a) Capacity requirements planning (CRP)

b) Order release planning

c) Operations sequencing

7- Plant monitoring and control (PMC)

Manufacturing Plant Monitoring and Control systems (PMC) provides performance measurement calculations and KPIs as management decision support sustainability as well as benefiting the business profitability. The basic functions are:

a) Preparing manpower attendance report

b) Reducing inventory on the shop floor

c) Controlling shop documentation

d) Assigning job based upon the work sequence

f) Monitoring and controlling direct machine

g) Inspecting and testing the shop floor

h) Material handling of raw materials, work pieces.

8- Plant maintenance

The aim is to manage plant equipment and spare parts while developing and executing your own maintenance schedules. High-level tracking of maintenance labor ensures your resources are used effectively. The functions included in this module are:

a) Establishing labor standards for maintenance

b) Automatic scheduling of preventive maintenance

c) Determining scheduled maintenance intervals

d) Dispatching maintenance jobs on priority basis

e) Costing maintenance jobs

f) Establishing maintenance labor force

9- Stores control

Manage the inventory, as well as options on how customizing inventory management for stores. It will also show you how to import/export product information. It involves the following functions:

a) Establishing basic disciplines required for effective control over physical in.

b) Controlling location of stocked items

c) Improving the efficiency of picking activities by filling requisition of needs

12- Cost planning and control

This module aims to utilize information generated in an Order of Cost Estimate through to an Indicative Cost Estimate and then onto a Detailed Cost Estimate to enable the analysis and control of any element in the organization. The topics that this module provides are:

a) Direct labor, material and other costs
b) Overhead costs, planning and control of divisional expense budgets
c) Long range planning of capital, expenditure and investment

2.8 Benefits of COPICS

COPICS act as a closed system and it well adapted to work with fluctuations in the production flow and to make the needed modifications. Communications oriented production information and control system Magazine (1972) showed benefits of COPICS and they are:

1- High productivity through effective utilization of production facilities.
2- Reduction of inventories
3- Improvement of service level
4- Realistic planning and allocation of production resources
5- Reduction of production times and costs
6- Timely and appropriate decisions to various changes of manufacturing environments etc.

2.9 Company Background

Electricity industry started in Jordan in 1937 when Amman municipality approved exchanging lighting of the streets of the municipality of Amman from kerosene lamps to electrical lamps. They were provided by Amman Company, in 1939 the company developed by establishing the first power generating plant in Jordan. The company developed its activities by lighting streets at night and continually providing consumers with power.

Therefore, Amman electricity was the first Arab company in charge of generating and distributing electricity through Arab funds and skills. After that In 1945 Jordan electricity partnership was established to replace Amman Electricity Company, In 1962 Jordan Electricity Company was incorporated with central Jordan Electricity Company in one company under name of Jordan Electricity CO. Ltd., during September 1996 JEA was converted to a public share-holding company wholly owned by the government called the National Electric Power Company (NEPCO).

In 2011 the national electricity company implemented a number of electrical projects in various parts of kingdom in order to develop and strengthen the national transmission network with the establishment and expansion of the main substations 400/132/33 kV and 132/33 kV, and the

establishment of 400 kV and 132 KV transmission lines necessary to connect the substations and new power plants with the electrical system. (NEPCO, 2011).

2.10 Maintenance

Since the early days of inventing the machines their complexity increased in rapid shape especially after inventing the electronic computer and designing the complex control systems which caused to developing the production process, and the need to optimal using of the available racecourses appeared that caused to operate the utility for 24 hours a day and 7 days a week , but new problem has been found which is the continuous operating of the utility doesn't allow to have an enough time for maintenance which will cause to exposure damage and that will lead to partially or completely stop depending on type of damage.

There are a lot of definitions of maintenance some of them are:

1- IEEE (2001) defined Maintenance as an activity to arrest, reduce or eliminate device deteriorations. The purpose of maintenance is to extend equipment lifetime, increase asset values (equipment conditions), and avoid costly consequences of failures.
2- Wireman (1994) define it as any activity carried out on an asset in order to ensure that the asset continues to perform its intended functions, or to repair the equipment. Note that modifications are not maintenance, even though they may be carried out by maintenance personnel.
3- Pintelon and Puyvelde (2006) defined maintenance as a group of activities needed to maintain equipment, installations and other physical utilities in the desired operating state or to restore them to this state .

2.11 Maintenance Objectives

Maintenance objective must support both the plants strategic and production plans; Gopalakrishnan and Banerji (2013) determined the main objectives maintenance as the following:

1- To have maximum availability of plant, equipment and machinery.
2- To maintain plant equipment and facilities at economic level of repairs at all times.
3- To provide management with information on cost and effectiveness of maintenance.
4- To ensure the working capital at appropriate levels.
5- To achieve all the above Objectives as economically as possible.

2.12 Maintenance Types

2.12.1 Corrective maintenance

Gali (2009) defined Corrective maintenance as “run it until it breaks” which mean we don’t need maintenance until the equipment can’t run again, it offers the advantages of less staff required and a low cost of on-going maintenance, but can result in unplanned equipment downtime, increased cost for equipment repair or replacement, possible downstream equipment/process damage and others.

Corrective maintenance is the applying of the unscheduled maintenance tasks to rescue the function ability of failed or stopped device or system. (Anthony and Hinchcliffe, 2004)

Mays and Tung (2002) defined Corrective Maintenance as “The activities of repair after a breakdown has taken place or as unscheduled maintenance due to equipment failure. “

2.12.2 Predictive Maintenance

The aim of predictive maintenance is to predict when equipment failure might occur, and to prevent occurrence of the failure by performing maintenance. Monitoring for future failure allows maintenance to be planned before the failure occurs.

It allows the maintenance frequency to be as low as possible to prevent corrective maintenance, without incurring costs associated with doing too much, condition-based strategy that examines the current status of the equipment before determining what, if any, maintenance is required. Advantages include a high return on investment, lower maintenance costs, fewer breakdowns, lower downtime and higher productivity.

Smith and Mobley (2008) defined predictive maintenance as “The monitoring of an asset’s health in order to anticipate the opportunities to proactive perform maintenance to preserve an asset from failure or to protect it in some way”.

Braunovic and Myshkin and Konchits (2006) defined Predictive Maintenance as “Maintenance initiated on the basic of observed present and projected future component conditions “ , the objective of it is to predict element performance so that repairs can be planned and completed before any equipment failure occurs .

2.12.3 Preventive Maintenance

Preventive maintenance is maintenance that is performed on a piece of equipment to lessen the likelihood of it failing. Preventative maintenance is performed while the equipment is still working, so that it does not break down unexpectedly, equipment failure is avoided by regularly scheduled maintenance which provides the advantages of greater cost-effectiveness, flexibility, increased equipment lifespan and lower failure rates.

Disadvantages include the continued potential for catastrophic failure, labor intensity, waste due to unneeded maintenance and others.

Anthony and Hinchcliffe (2004) defined Preventive Maintenance as the performance of checking and service tasks that have been schedule for accomplishment a define point in time to retain the function ability of operating device or system.

British Standards Institute (1984) defined Preventive maintenance as "the maintenance carried out at predetermined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure or the performance degradation of an item."

Cruzan (1970) defined Preventive Maintenance as a planned program of regular tests, modification, adjustment, lubrication or changing of failing parts in order to maintain and facility performance and efficiency.

Table (2.2) shows the benefits, Examples and who can do each type of maintenance

Table 2.2
Maintenance types

	Corrective Maintenance	**Predictive Maintenance**	**Preventive Maintenance**
Examples	Replacing parts	1. Vibration Analysis 2. Oil Analysis 3. Visual Inspections	1. Greasing 2. Changing filters 3. Oil changes
Benefit of it	Their Negatives are more than their benefits	1. Provides increased operational life 2. Results in decrease of downtime 3. Allows for scheduled downtime 4. Lowers need for extensive parts inventory	4. Increases life of equip. 5. Reduces failures and breakdowns 6. - Reduces down time 7. - Decreases cost of replacement
Who does it	Usually be performed by an Expert stuff to determine the root cause of this failure	PdM should only be performed by trained personnel using proper equipment	Only trained, qualified maintenance personnel should perform PvM

Figure (2.1) shows how the relation between costs maintenance and maintenance effeteness is and how is the distribution of maintenance type change with Costs and Effeteness of Maintenance.

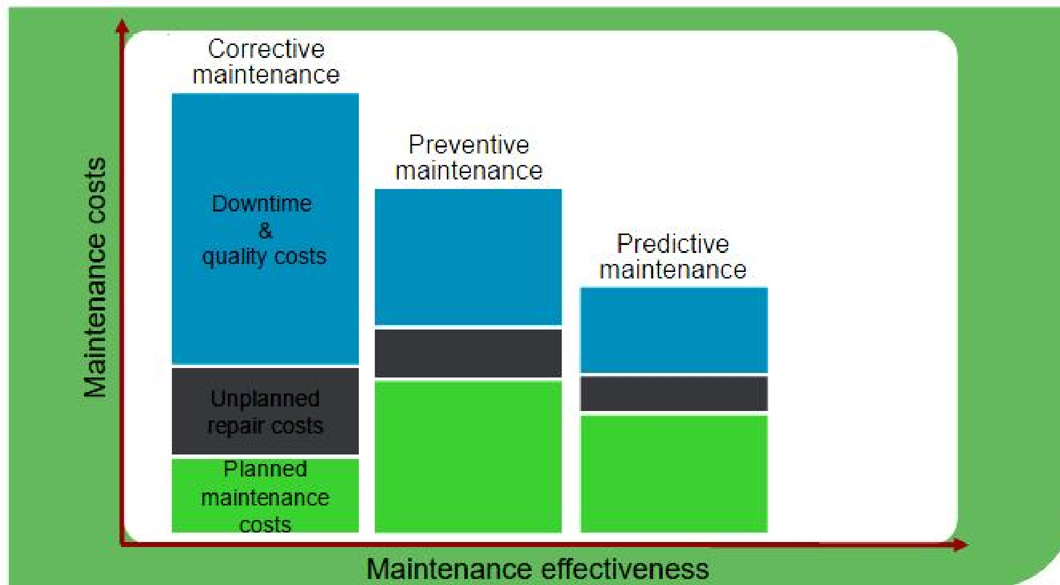


Fig 2.1

The relation between maintenance cost with the maintenance effectiveness

The right Steps to implementation the maintenance:

1- Determine the machines and the equipment that need maintenance.
2- Determine the total maintenance processes from the manual given by the supplier or the factory that existing in the maintenance manuals.
3- Create the maintenance process schedules depending on the type of maintenance.
4- Using the maintenance plan.
5- Choose and train the technical labor.
6- Provision of spare parts.
7- Provide a number of tools.
8- Introduction of recording information system: the system is working.
9- Organization of the work of maintenance and distribution of responsibilities.
10- Monitor the implementation of the maintenance plan.

2.13 Maintenance Performance

Maintenance is a group of activities that performed to maintain machines and equipments in the existing state and save it from failure and warrant their continuous operating in a good state. For this reason the real importance is to monitor and improve the maintenance activities to warrant the effective process.

According to Ahren (2008) in order to monitor and evaluate the effectiveness and efficiency of maintenance performance and a commitment to the maintenance activities, we need to use the performance measurement system which generates performance indicators because we cannot manage performance if we cannot measure it.

Performance measurement is a number and a measuring unit, and there are a group of indicators used to measure the maintenance performance which called “key Performance Indices KPI’s”, which are variables that provide information about a specific factor within the organization such as the operations, people, the cost, and the quality, and the indicators should be few, easy to understand and measurable. (Kumar, et. al., 2010)

There are many categories of maintenance performance indicators in the literature reviews, some of them as Albert (1999) defined are as Table (2.3) shows:

Table 2.3
Maintenance Performance Indicators

Category	Indices
Equipment performance metrics	Readiness, reliability, effectiveness of public Equipment
Cost performance metrics	The cost of maintenance, labor, and materials
Process performance measures	the proportion of planned work to unplanned and compliance Scheduling

2.14 Literature Review:

Field survey of the literatures and the previous studies results indicate that there isn’t any previous studies; as the knowledge of the researchers; that search in direct for of the impact of applying production management techniques on the maintenance of electrical utilities in the National Electric Power Company, so this study tried to employ what came in the previous studies as much as possible to achieve their goals.

(Mahmoudi, El barkany and El khalfi, 2013)MV Electrical Network Maintenance Strategy: A New Management Approach. This study took place in Morocco country aimed to find a new strategies to provide a reliability criteria and minimizing the total cost that spent to ensure the utilities and maintain it in a proper condition, and it described the import of the availability of the energy of national economy and to show the deployment of an efficient management.

In order to establish a policy of optimizing maintenance resources, and to develop an approach for prioritizing maintenance work, to optimize spending, and improve the Key Performance Indicators (KPI’s) of quality of electricity supply (System Average Interruption Duration Index (SAIDI), System Average Frequency Duration Index (SAIFI) and Energy Not Supplied (ENS)).

In this study, the researcher have proposed a methodological approach aiming for planning maintenance actions sound and should provide utilities with a structured approach to a maintenance program with an optimum

balance between cost of maintenance and reliability improvement, and to maintain functionality under safe and efficient conditions of the distribution network.

The benefit of this study to the researcher in understanding the way that the researchers used to assess the maintenance activities and how to implement a performance indexes to measure the effective applying of maintenance.

(ALShA'AR and ALNAGAR, 2015) Total quality Management (TQM) Applications and their impact on the technological innovation in management applications (Case Study on operating banks in Jordan). This study aimed to identify the total quality management applications and its impact on technological innovation in the operating banks in Jordan.

Results of the study showed that the level of Total quality management applications in terms of the relative importance was high, Results of the study also showed that there is a statistically significant effect of the application of total quality management on technological innovation , It was found that the overall strategic planning, participation and empowerment of workers, and continuous improvement have had the most impact and the most prominent in technological innovation and it recommended to promote the adoption of banks senior management the application of total quality management programs through the necessary support for these programs.

Both morally and supervision or participation through financial support necessary for the completion of such programs, pay attention to the process of technological innovation and continuously renewed, and not only to achieve a one-time or a certain time, encourage creative ideas and attention by providing an appropriate environment to encourage creativity process inside the banks.

The benefit of this study to the researcher in understanding the idea that has been applied to operating banks in Jordan, and focus on the principles of the total quality management.

(Ben Hmida and Gaspard and Lee, 2013) TQM-Based Equipment Maintenance in Oilfield Service Industries.

This study suggested that a Total Quality Management (TQM) based equipment maintenance program that focuses on employee empowerment and structured communication channel can reduce equipment failure and downtime. Various TQM tools are suggested to deal with the maintenance issues identified in the management level. Maintenance procedures and work instructions are then evaluated with new procedures proposed in the operational level to implement the TQM concepts. And it concluded that The TQM philosophy will influence management's decisions and actions. Overall, management will adopt a proactive approach to equipment maintenance.

A chain of command will be defined to eliminate questionable authoritative boundaries. Also, communication channels will be structured to reinforce the circulation of accurate and verifiable information. The importance step in building up the TQM based program is to further develop the components needed in the equipment maintenance at the operational level: the quality procedure, the maintenance program, and customer satisfaction program that match the new management infrastructure.

The usefulness of this study to this researcher that they found a communication channels to reduce breakdowns and stop equipment and to promote accurate and trading information to verify and develop the necessary elements in the maintenance of equipment at the operational level, such as customer satisfaction program.

(WAHHAB and ALSMMAk, 2012) ISO-9000 Quality Management System in improving performance of Maintenance Function (Case Study the public Company of Northern Cement)

The research aims to indicate the extent of the contribution of quality management system ISO 9001: 2008 in improving the performance of the maintenance function in the organization surveyed, and included variables
Standard ISO 9001: 2008 five clauses the represented by (quality management system, management responsibility, resource management, product realization, measurement analysis and improvement), while the included variables performance the function of maintenance, performance indicators major maintenance (KPIs), these indicators are classified into two groups: the set of indicators advanced (Leading), and the last set of indicators (Lagging).

The Search adopted on the hypothesis that "the quality management system ISO 9001: 2008 contributes actively to improve the performance of the maintenance function in the organization surveyed." The Search based mainly on the checklist (Checklist) to measure the extent of the application requirements of international standard as well as measuring the extent to which the organization surveyed used the maintenance key performance indicators. The research found a set of conclusions, including: the organization has achieved a great touch with the requirements of quality management system after applying the requirements of international standard. and the Search suggested the need to preserve the gains achieved by the application of quality management system and maintain the effectiveness of the quality system applied through continuous improvement.

The usefulness of this study to the Research is that the total quality management is a factor of improving maintenance performance factors which helps companies to obtain ISO certification.

(Khashoggi, 2003) Total quality management models and the constraints that prevent of their application in the Arab security systems. The researcher aimed to analyze a three main and important axes of total quality management to benefit from them when trying to apply it in public or private organizations, and the research included analysis of total quality management models, analysis of total quality management elements and their principles and the constrains that prevent of the successful of the applying of total quality management in the arabic management. The results of this study were that the total quality management will not applied successfully without the investment in the learning programs and the continuous training of the human recourses and the customers are the main corner of all quality improvement processes and that the improvement of quality need a long time and it done throw the application of scientific methods.

The benefit of this study to the research is in support the search on the principles of total quality management such as customer's satisfaction, top management support and training.

(Abu Zyeada, 2012) The Effect of Time and Total Quality Management on the Job Performance:

A Field Study on Samples of Palestinian Commercial Banks.

The research in this study investigate the relation between time and total quality management and their effect on the job performance of Palestinian commercial banks, he used the questionnaire to gather the data from the workers in the banks and he conclude that many banks in Palestine care about the concept of total quality management , and he showed that there is a relation with good significant effect between total quality management and time management and job performance too , the result of this study was that applying time and total quality management together has more effect on job performance than applying each principle in individual form.

This study helped the research on forming the questionnaire and the theoretical frame work building.

(Al-Azemi, 2015) The Impact of Applying Total Quality Management and Kaizen Methods on the Maintenance of Electricity Generation Plants in the Ministry of Electricity and water in Kuwait. This study done in Kuwait and it analyzed the administrative systems in the ministry of electricity and public water, the aims of this study were to clarify the concept of total Quality Management and kaizen philosophies , compare between these two philosophies and theirs applications in maintenance and the development of the electricity sector to reach the best results in management. The researcher used the questionnaire methodology to get the information from the employee and the result of this study was fifty five percent of employee see that kaizen philosophy were rational employed in the electricity sector,

sixty five percent of employee think that the total quality management is the best philosophy to be applied in the electricity sector and fifty percent of employee see that both philosophies achieving the growth for the electricity sector.

The benefit of this study to research from the point that it was applied in electrical sector in Kuwait which is similar to this research.

(Atlason, Oddsson and Unnthorsson, 2014) Geothermal Power Plant Maintenance: Evaluating Maintenance System Needs Using Quantitative Kano Analysis. The researchers used quantitative Kano model in this study to determine the features that preferred by top-level maintenance engineers within Icelandic geothermal power plants to be used as a maintenance tool or software. The researchers interviewed the chiefs of operations and maintenance were used as a basis for a quantitative Kano analysis and they found that 30% of all maintenance engineers at Reykjavik Energy and Landsvirkjun, responsible for 71.5% of the total energy production from geothermal resources in Iceland, answered the Kano questionnaire. The results of this study were that solutions focusing on

(1) Planning maintenance according to condition.
(2) Shortening documentation times.
(3) Risk analysis are sought after by the energy companies but not provided for the geothermal sector specifically.

The benefit of this study to research that the using of computer models will help in reducing the documentation time and reduce the costs of storing it.

(Mukattasha, et al, 2011) Computer –Aided Maintenance Planning System for Industrial Companies

The researchers developed a general guide, which can be applied to unique situations to assist in using of the computer for Maintenance System Evaluation. Maintenance System Evaluation has always required the manipulation of huge amounts of data and development of more cost-effective processing storage and database systems has brought the use of computers to the fore in this area. Since, the relationships are complex between factors affecting maintenance activities and their interactions; a computer-aided model was developed with main purpose of determining the evaluation factors and their pointers.

The model that the researchers built will approximate the complex relations for practical purposes. A model with eight various factors and there pointers for Maintenance System Evaluation were proposed in this study. The MSE approach uses the input data as well as the factors that reflect specific operating conditions and unique objectives of the firm. The model would help in measuring the effectiveness of maintenance activities in order to determine the deviations from the planned work. It will also

perform instant corrective actions required according to the degree of deviation and its effect on the production continuation and with the minimum shutdowns possible.

The benefit of this study to research is that using computer software will help in measuring the effectiveness of maintenance activities in order to determine the deviations from the planned work which where used as a paragraph in the questionnaire.

(Zijm, 2000) Towards intelligent manufacturing planning and control systems. In this study the researcher reviewed some of the manufacturing planning and control systems and he shed the light on their positives and negatives. The analysis showed that various important planning and control problems are not properly addressed by current manufacturing planning and control systems.

Then researcher gave a brief about the two systems which were pull systems such as just in time, Kanban and workload control and Push systems such as material requirements planning and manufacturing resources planning , after that the researcher showed a historical preview of Hierarchical production planning and multi-echelon inventory systems and supply chain management. Then he talked about manufacturing system typology suck as Make and assemble to stock (MATS) , Make to stock, assemble to order (MTS/ATO), Make to order (MTO) and Engineer to order (ETO).

This study helped the researcher in the identifying on the production management techniques and their historical development such as just in time and kanban.

(Zawawi, et. al., 2009) A Quick Survey on Maintenance Management Practice in Malaysian Building. This study done in Malaysia the researchers aimed to determine and discuss the common factors that cause the poor maintenance management experienced in Malaysian building industry. The research used the questionnaire to get the information from the population which was three types of buildings hotels, high-rise offices and hospitals. The result of this study was most buildings face similar problems in terms of breakdowns and other weaknesses that have an effect on the quality of the system, Scheduling and prevention planning would be good solutions to improve this situation. The study has also found that most organizations need to be careful when hiring people to work in the maintenance department, and they need a good training to do their jobs in the best form.

This study helps the research on the identifying the maintenance types and the definitions of each one of them, such as planned and preventive maintenance.

(Tahboub, 2011) An Assessment of Maintenance Practices and problems in Jordanian Industries. This study done in Jordan from the need

to use a correct maintenance of production equipments and systems and fro the increasing in complexity and difficult in control. The study objective was assessing the maintenance needing in Jordan industries. To confirm this goal, a questionnaire was designed in order to investigate maintenance needs and problems, namely, maintenance planning, spare parts, equipment calibration and maintenance staff training.

The questionnaire was distributed on a selected sample of Jordanian industries and was filled, mostly, through personal interviews. Then the collected data were analyzed using SPSS software, the results of this study were that most of the industrial firms in Jordan have maintenance departments, but still not all of them allocate budgets to these departments. About half of the firms apply preventive maintenance along side with corrective maintenance; the major problem is the unavailability of spare parts in the local market and the researcher concluded regarding the current situation of maintenance in Jordanian industries were derived.

This study helped the research on identifying the impact of crew training on the maintenance effective, and to identify the preventive and corrective maintenance.

(Sharma, Gupta and Singh, 2014) Implementation of TQM for Improving Organizational Effectiveness. This study shows an analytical study on the relationship between total quality management (TQM) and the organization effectiveness in India The aim of this study was to understand the importance of Total Quality Management (TQM) philosophy and attempting to integrate the concept of TQM implementation within a broader perspective of business as a part of corporate strategy in an organization. The concerns and issues for TQM implementation were discussed too. This paper attempted to give a holistic perspective of TQM implementation as a part of Business Excellence Strategy Implementation.

Large companies had higher Implementation levels across almost all practices except for teamwork and open organization when compared to small- and medium-sized companies. TQM practices were statistically more significant in manufacturing companies compared to service companies and firms having a higher degree of innovation also showed higher levels of TQM practice implementation. The conclusions of this study were the effective TQM implementations improve organizational effectiveness, long-term profitability and financial returns and higher intensity of TQM practices results in improved quality performance.

The benefit of this study to research is that the total quality management is an important strategy of company strategies.

2.15 Benefit from the previous studies

These studies have provided a group of benefits to research and they are:

1- Benefit from the previous studies in choosing study methodology and statistical techniques and how to analyze the data in these studies.
2- Benefit from the previous studies in the presentation of the theoretical framework.
3- Benefit from the previous studies in the formation of the questionnaire.
4- Benefit from the references and books that have been adopted by previous studies to save time and effort.
5- The link between the results of this study with the results of previous studies.

2.16 Summary of Literatures Review

From the previous studies about production management techniques and the maintenance can conclude that all of them tried to cover the issue of the application of production management techniques in several areas and they all agreed on the need to adopt the philosophy in the various communities in which it conducted these studies.

As it's cleared form the showing of the previous studies that:

1- Previous studies have stressed the need to production management techniques in the various communities in which it conducted these studies.
2- Studies have shown the importance and role of production management techniques in the improvement and development of administrative and technical performance of maintenance in companies and institutions.
3- Total quality management help to reduce the waste in the output of national electric power company.
4- Shows the concepts of total quality management and their principles.
5- Shows the types of maintenance and the definitions of each type.
6- Shows the comparison between total quality management and the traditional management approach.
7- Shows some of the maintenance management system that were been used in some companies and organizations.
8- Identify on the ways of assess the maintenance activities in the company using key performance indices.

2.17 The Relation between the Present Study and the other works:

Table 2.4

Relation between the Present Study and the other works

NO.	Study	Relation to this Study
1.	Mahmoudi, El barkany and El khalfi (2013)	related to this researcher from the point that it's studied the maintenance strategy of MV electrical network and how to implement a performance indexes to measure the effective applying of maintenance
2.	ALShA'AR and ALNAGAR (2015)	Related to this research by its studied total quality management applications in the banks in Jordan and their impact on the technological innovation.
3.	Ben Hmida and Gaspard and Lee (2013)	Related to this research by its studied the impact of total quality management on the maintenance in oilfield service industries which is ear to the electrical utilities.
4.	Wahhab and ALsmmak (2012)	Related to study by its studied role of total quality management in improving performance of maintenance functions in the public company of north cement and used the KPI's to measure the maintenance performance.
5.	Khashoggi (2003)	Related to this study by its studied the total quality models and constrains that prevents of their application in the Arab security systems to avoid it in this study.
6.	Abu Zyeada (2012)	Related to this study by its studying the The Effect of Time and Total Quality Management on the Job Performance in Palestinian commercial banks.
7.	Al-Azemi (2015)	Related to this study by it studying the same problem which is the impact of total quality management on the maintenance in the electricity sector in Kuwait.
8.	Atlason, Oddsson and Unnthorsson (2014)	Related to this study by its studying the maintenance system in the geothermal power plants.
9.	Mukattasha, et al (2011)	Related to this study by its studying the planning of maintenance activities using the computer- Aided system and their benefits.
10.	Zijm (2000)	Related to this research from the point its studied the new production technique which is intelligent manufacturing and control systems.
11.	Zawawi, et. al. (2009)	Related to this study by its studying the maintenance system in the geothermal power plants.
12.	Tahboub (2011)	Related to this research from the point its studied the new production technique which is intelligent manufacturing and control systems.
13.	Sharma, Gupta and Singh (2014)	Related to this research by its studied the implementation of total quality management for improving the organizational effectiveness.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This chapter deals with a comprehensive field study carried out by the researcher to achieve the objectives of the study and a description of the procedures and includes the identification of the approach taken in the study, and the community of the study and the study sample, and then addresses the study tool and how to build it, and procedures that were used in the examination of the study tool and statistical methods and treatments that have been relied upon to analyze the data and test the hypothesis and questions the study in order to reach results that reflect the reality of the phenomenon under study.

3.2 Study Methodology

Descriptive analytical method was used which is based on accurate observation of the phenomenon or a given event and follow-up in a way the quantity or the quality of the time period or several periods in order to identify the phenomenon or event in terms of content, and access to the results and generalizations help in the understanding of reality and develop it, and researcher adopted on two types of sources for data collection are:

1- Primary sources:

The designed questionnaire consists of a group of questions to determine the impact of production techniques on the maintenance of electrical utilities in the national electric power company (NEPCO), where the previous studies used to help in formulating a questionnaire.

2- Secondary sources:

It has been revised thesis's, books, periodicals and publications and scientific journals and websites on the Internet related to the subject of study, and through secondary sources the researcher knew the ways in the writing of research and knowledge of the scientific aspects of a subject of the study which are the production management techniques and maintenance.

3.3 Study Population

Study population consist of the workers in the maintenance sections (Substations maintenance section, Transmission Lines maintenance section, electromechanical maintenance section and protection maintenance section), where the number of study population is about (500) employee.

3.4 Study Sample

A random simple sample were selected which has a size of (102) employee and formed a percent of (20.4%) of the study population, five

questionnaires were excluded for non-suitability for statistical analysis, so that the total questionnaires that were subjected to statistical analysis total reached (97) questionnaires by (19.4 %) of the study population, and the rate of (95.1%) of the study sample. Table 3.1 shows the characteristics of the study sample:

Table 3.1
The distribution of the study sample

Variables	Variable categories	Number	Percentage %
Gender	Male	86	88.7
	Female	11	11.3
Age In years	Less than 25	19	19.6
	25 -35	39	40.2
	35 – 45	26	26.8
	More than 45	13	13.4
Qualification	Secondary	21	21.6
	Diploma	23	23.7
	Bachelor	41	42.3
	Master	12	12.4
	Ph.D.	0	0
Job Title	Technical	28	28.9
	Supervisor	17	17.5
	Engineer	27	27.8
	Section Head	10	10.3
	Dep. Manager	5	5.2
	Other	10	10.3
Experience In years	less than 5	24	24.7
	5-10	28	28.9
	10-15	24	24.7
	More than 15	21	21.6
Department	Substations	22	22.7
	Transmission lines	26	26.8
	Electromechanical	19	19.6
	Protection	21	21.6
	Other	9	9.3

3.5 Study Tools

A questionnaire has been prepared for the purpose of data collection, and included two parts, the first dealt with a description of the personal and functional variables, and the second question 37 as follows:

1- Questions (1-6) measure the impact of applying of total quality management (TQM) on corrective maintenance (CM).
2- Questions (7-12) measure the impact of applying of Communication-Oriented production information control system (COPICS) on corrective maintenance (CM).
3- Questions (13-18) measure the impact of applying of total quality management (TQM) on predictive maintenance (PdM).
4- Questions (19-24) measure the impact of applying of Communication-Oriented production information control system (COPICS) on predictive maintenance (PdM).
5- Questions (25-31) measure the impact of applying of total quality management (TQM) on preventive maintenance (PvM).
6- Questions (32-37) measure the impact of applying of Communication-Oriented production information control system (COPICS) on preventive maintenance (PvM).

Paragraphs were given the following weights: Strongly Agree (4) degrees, agree (3) degrees , Disagree (2) degrees and Strongly Disagree (1) degree, and It were dealing with the arithmetic averages of the answers to single sample in accordance with the following Grade:

High	Medium	Low
More than 3	2-3	Less than 2

3.6 Tool Validity

The questionnaire was displayed on a number of specialist professors in the Faculty of Engineering and Business Administration at the University of Mutah to get to know their views and suggestions on the paragraphs of the questionnaire. It was adherence to their observations until the questionnaire appeared in a form that serves the objectives of the study.

3.7 Tool Stability

The tool stability was verified based on the data entered on the computer through software (SPSS) to know the stability of the reality of Cronbach's alpha for internal consistency equation. As the value of the overall reliability coefficient (0.957) and this percentage is high and demonstrates the consistency and coherence between the paragraphs of the tool , and stability coefficients values ranged between (0.812- 0.866), and the following table shows the values of reliability coefficients:

Table 3.2
Stability coefficients values

NO.	Field	Stability coefficients values (Cronbach's alpha)
1	Impact of Apply TQM on The Corrective Maintenance	0.812
2	Impact of Apply COPICS on The Corrective Maintenance	0.825
3	Impact of Apply TQM on The Predictive Maintenance	0.830
4	Impact of Apply COPICS on The Predictive Maintenance	0.866
5	Impact of Apply TQM on The Preventive Maintenance	0.862
6	Impact of Apply COPICS on The Preventive Maintenance	0.859
	Total Questionnaire	**0.957**

3.8 Statistical Methods

1- Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Together with simple graphics analysis, they form the basis of virtually every quantitative analysis of data.

2- Test (One Sample T-Test) where the premise center determined as (Test Value= 2.0), One sample t-test is a statistical procedure used to examine the mean difference between the sample and the known value of the population mean. In one sample t-test, the population mean is known. a random sample drawn from the population and then compare the sample mean with the population mean and make a statistical decision as to whether or not the sample mean is different from the population mean.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Results

Table 4.1 shows the distribution of the study sample according to gender, where it was noted that males represent about (88.7%) of the study sample which reflects that the male's employee is larger than the female's employee in the maintenance departments, which just represented (11.3%) of the study sample.

Table 4.1
The distribution of the study sample by gender

Gender	Number	Percentage
Male	86	88.7%
Female	11	11.3%
Total	97	100%

Also fig (4.1) shows the distribution of the study sample according to gender for what came in table (4.1).

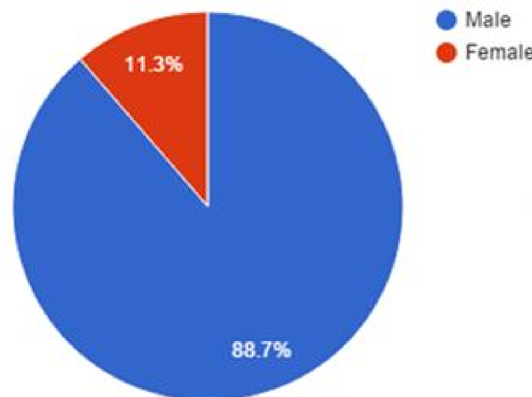


Fig 4.1
The distribution of the study sample according to gender

Table (4.2) shows the distribution of the study sample according to age, where it was noted that those aged 25 to 40 represented the largest proportion of the study sample with a ratio of (40.2%) and the lowest ratio was those aged more than 45 and this shows that the youth constitute the largest number of employee of the maintenance departments.

Table 4.2
The distribution of the study sample according to age

Age	Number	Percentage
Less than 25	19	19.6%
25-35	39	40.2%
35-45	26	26.8%
More than 45	16	13.4%
Total	97	100%

Also Figure (4.2) shows the distribution of the study sample according to age for what came in table (4.2).

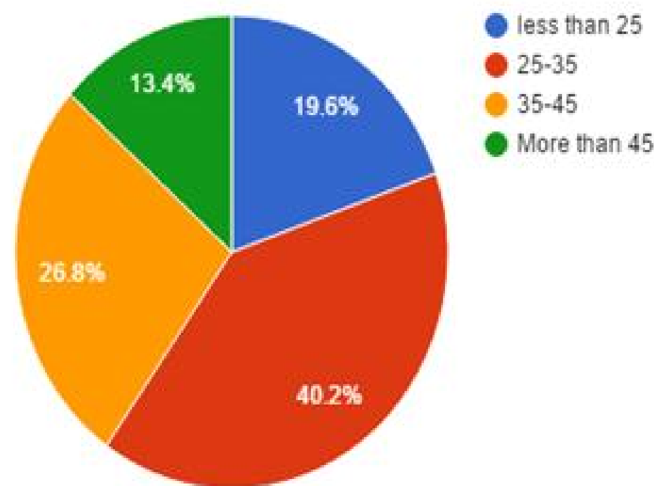


Fig.4.2
The distribution of the study sample according to age

Table (4.3) shows the distribution of the study sample according to Qualification, where it was noted that those who have bachelor degree represents the largest proportion of the study sample with a ratio of (42.3%) and the lowest ratio was those who have a master degree with a ratio of (12.4%), either those who have a secondary degree represents a ratio of (21.6%) and those who have a diploma degree represents a ratio of (23.7%), this shows that most of employee who get the master degree leave the working in the maintenance departments to get a managerial job or another job.

Table 4.3
The distribution of the study sample according to Qualification

Qualification	Number	Percentage
Secondary	21	21.6%
Diploma	23	23.7%
Bachelor	41	42.3%
Master	12	12.4%
Total	97	100%

Also Figure (4.3) shows the distribution of the study sample according to Qualification, for what came in table (4.3).

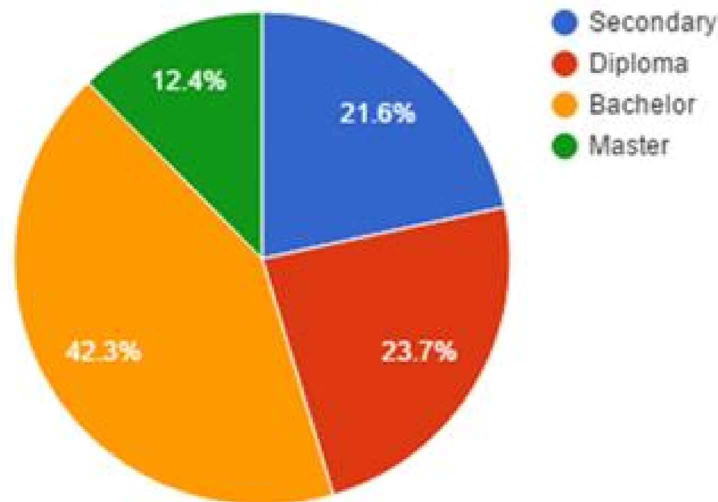


Fig.4.3
The distribution of the study sample according to Qualification

Table (4.4) shows the distribution of the study sample according to job title, where it was noted that those who work as technical represents the largest proportion of the study sample with a ratio of (28.9%) and the lowest ratio was those who work as Dep. Manager with a ratio of (5.2%), and those who work as section head represents a ratio of (10.3%) and those who work as engineer represents a ratio of (27.8%) and those who work as supervisor represents a ratio of (17.5%), and the other job title represent a ratio of (10.3%), this shows that the maintenance system in the national electric power company is a Hierarchical system.

Table (4.4)
The distribution of the study sample according to job title

Job Title	Number	Percentage
Technical	28	28.9%
Supervisor	17	17.5%
Engineer	27	27.8%
Section Head	10	10.3%
Dep. Manager	5	5.2%
Other	10	10.3%
Total	97	100%

Also figure (4.4) shows the distribution of the study sample according to job title for what came in table (4.4).

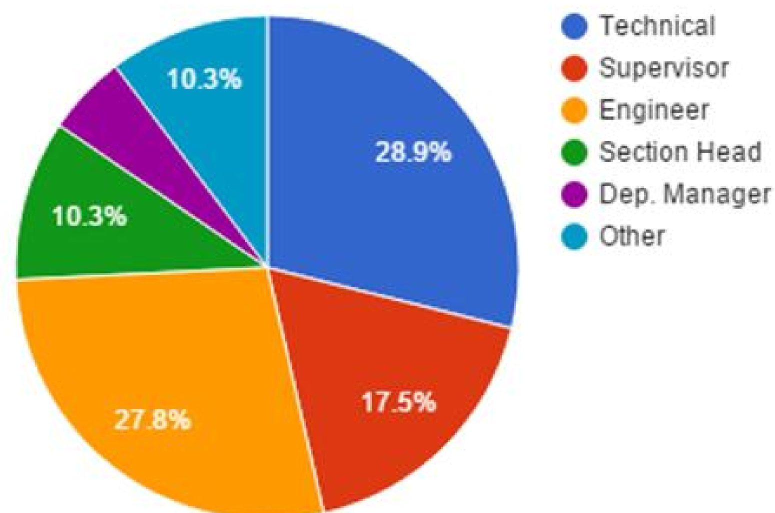


Fig. 4.4
The distribution of the study sample according to job title

Table (4.5) shows the distribution of the study sample according to Experience years, where it was noted that those who have an experience years between 5-10 represents the largest proportion of the study sample with a ratio of (28.9%) and the lowest ratio was those who have an experience years more than 15 with a ratio of (21.6%), either those who have an experience years between 10-15 represents a ratio of (24.7%) and those who have an experience years less than 5 represents a ratio of (24.7%).

Table.4.5
the distribution of the study sample according to Experience years

Experience years	Number	Percentage
Less than 5	24	24.7%
5-10	28	28.9%
10-15	24	24.7%
More than 15	21	21.6%
Total	97	100%

Also figure (4.5) shows the distribution of the study sample according to Experience years for what came in table (4.5)

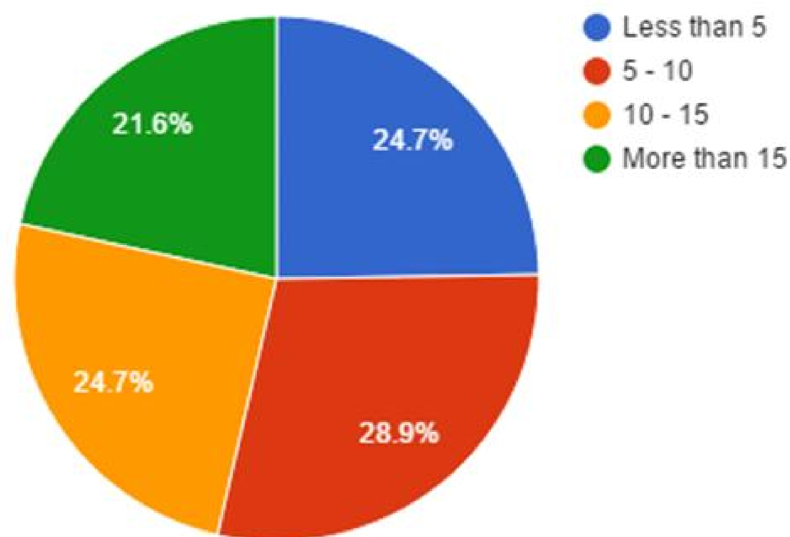


Fig. 4.5
The distribution of the study sample according to Experience years

Table (4.6) shows the distribution of the study sample according to Department, where it was noted that those who work in Transmission lines department represents the largest proportion of the study sample with a ratio of (26.8%) and those who work in substations department represents a ratio of (22.7%), and those who work in electromechanical department represents a ratio of (19.6%) and those who work in protection department represents a ratio of (21.6%) and the other departments represent a ratio of (9.3%)

Table.4.6
The distribution of the study sample according to department

Department	Number	Percentage
Substations	24	22.7%
Transmission lines	28	26.8%
Electromechanical	24	19.6%
Protection	21	21.6%
Other	9	9.3%
Total	97	100%

Also figure (4.6) shows the distribution of the study sample according to department for what came in table (4.6)

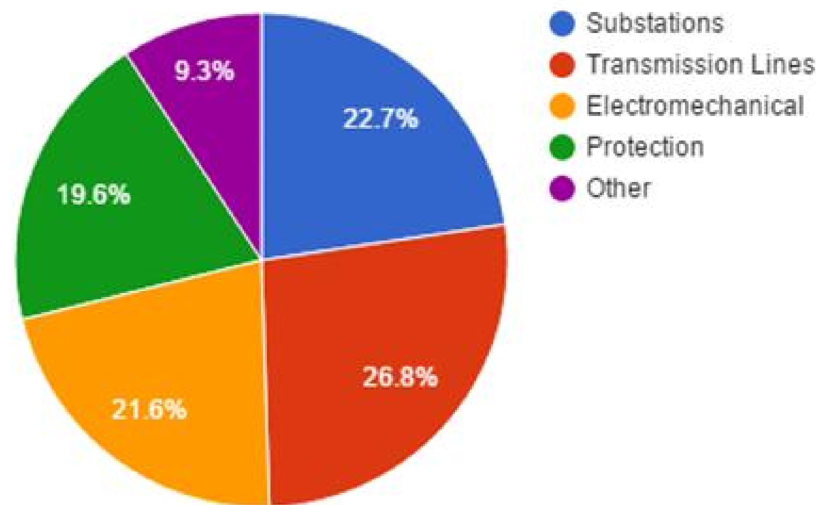


Fig. 4.6
The distribution of the study sample according to department

4.2 Statistical Analysis

Results related to the first hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Corrective Maintenance).

Key informant answers to Question (1) "using tools of TQM cause and effect, fishbone and ishikawa diagram will help to find the root causes of the problems"

The frequencies and the percentage of the answers for this question were as shown in table (4.7) and figure (4.7), which show that the number of employees who they strongly agree with it is (8) with a percentage of (8.2%) , while the number of employees who agree with it is (62) with a percentage of (63.9%) , and the number of employee who they disagree

with it is (27) with a percentage of (27.8%) , and there isn’t any of employees who they strongly disagree with it.

Table 4.7
Frequency distribution of question (1)

Answer	Number	Percentage
Strongly Agree	8	8.2%
Agree	62	63.9%
Disagree	27	27.8%
Strongly Disagree	0	0%
Total	97	100%

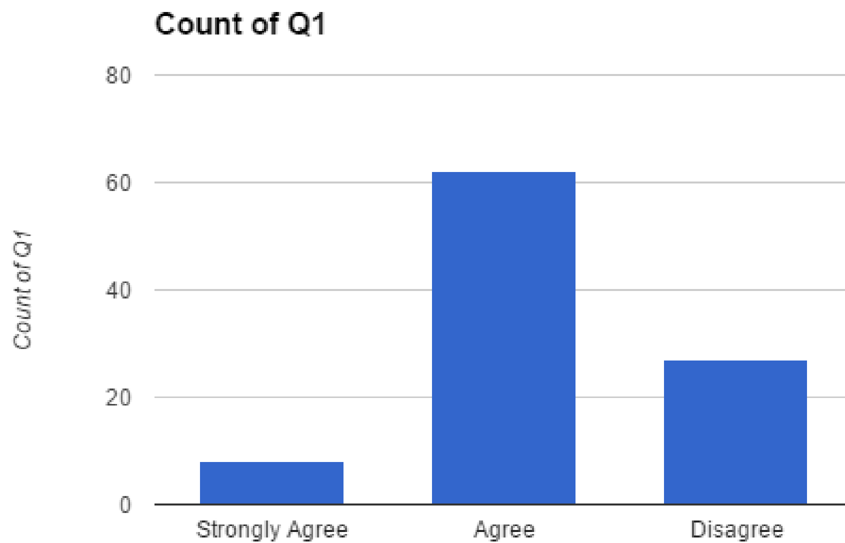


Fig. 4.7
Frequency distribution of question

(1)Key informant answers to Question (2) “Recorders kept for future decisions makings will help in dealing will similar events”

The frequencies and the percentage of the answers for this question were as shown in table (4.8) and figure (4.8), which show that the number of employees who they strongly agree with it is (26) with a percentage of (26.8%) , while the number of employees who agree with it is (48) with a percentage of (49.5%) , and the number of employee who they disagree with it is (20) with a percentage of (20.6%) , and the number of employee who they strongly disagree with it is (3) with a percentage of (3.1%).

Table 4.8
Frequency distribution of question (2)

Answer	Number	Percentage
Strongly Agree	26	26.8%
Agree	48	49.5%
Disagree	20	20.6%
Strongly Disagree	3	3.1%
Total	97	100%

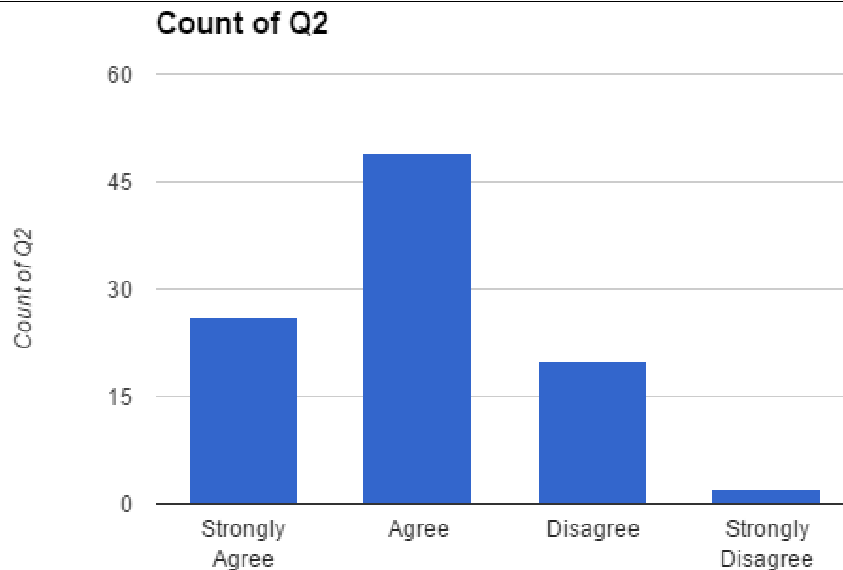


Fig. 4.8
Frequency distribution of question (2)

Key informant answers to Question (3) "Adequate ventilation, first aid and personal protective item should be available"

The frequencies and the percentage of the answers for this question were as shown in table (4.9) and figure (4.9), which show that the number of employees who they strongly agree with it is (25) with a percentage of (25.8%) , while the number of employees who agree with it is (40) with a percentage of (41.2%) , and the number of employee who they disagree with it is (31) with a percentage of (32.0%) , and the number of employee who they strongly disagree with it is (1) with a percentage of (1.0%).

Table 4.9
Frequency distribution of question (3)

Answer	Number	Percentage
Strongly Agree	25	25.8%
Agree	40	41.2%
Disagree	31	32.0%
Strongly Disagree	1	1.0%
Total	97	100%

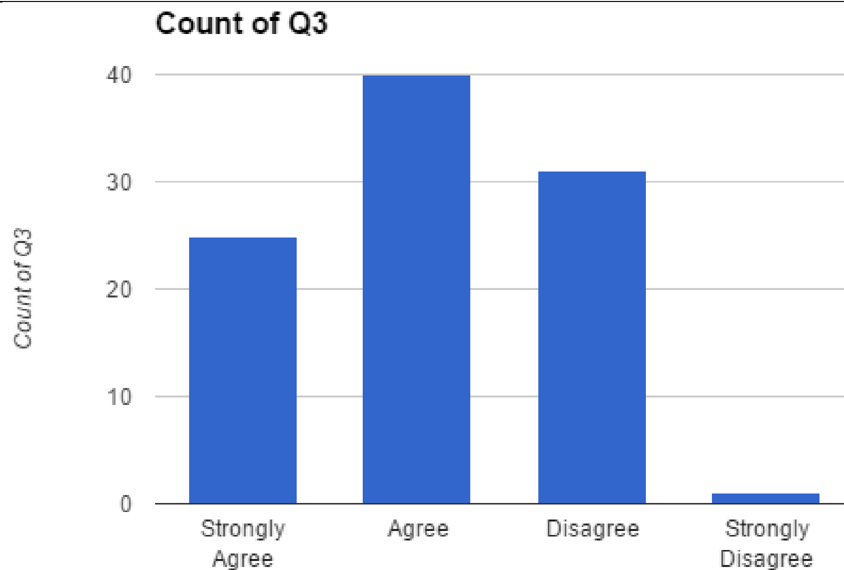


Fig. 4.9
Frequency distribution of question
(3) Key informant answers to Question (4) "Frequencies of corrective operations (rework) should be noted as performance index"

The frequencies and the percentage of the answers for this question were as shown in table (4.10) and figure (4.10), which show that the number of employees who they strongly agree with it is (16) with a percentage of (16.5%) , while the number of employees who agree with it is (47) with a percentage of (48.5%) , and the number of employee who they disagree with it is (33) with a percentage of (34.0%) , and the number of employee who they strongly disagree with it is (1) with a percentage of (1.0%).

Table 4.10
Frequency distribution of question (4)

Answer	Number	Percentage
Strongly Agree	16	16.5%
Agree	47	48.5%
Disagree	33	34.0%
Strongly Disagree	1	1.0%
Total	97	100%

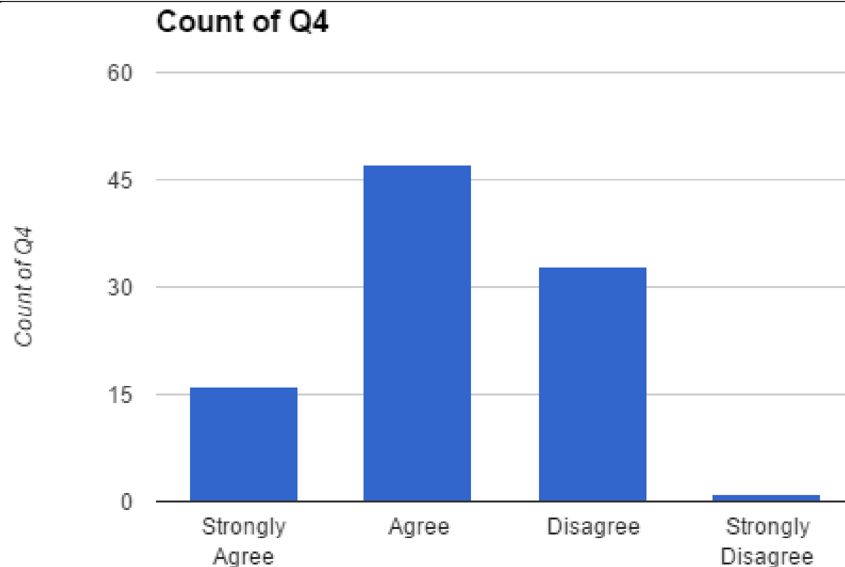


Fig. 4.10
Frequency distribution of question
(4) Key informant answers to Question (5) "Delegation of responsibility is essential for over or overall operation success."

The frequencies and the percentage of the answers for this question were as shown in table (4.11) and figure (4.11), which show that the number of employees who they strongly agree with it is (23) with a percentage of (23.7%) , while the number of employees who agree with it is (50) with a percentage of (51.5%) , and the number of employee who they disagree with it is (20) with a percentage of (20.6%) , and the number of employee who they strongly disagree with it is (4) with a percentage of (4.1%).

Table 4.11
Frequency distribution of question (5)

Answer	Number	Percentage
Strongly Agree	23	23.7%
Agree	50	51. 5%
Disagree	20	20.6%
Strongly Disagree	4	4.1%
Total	97	100%

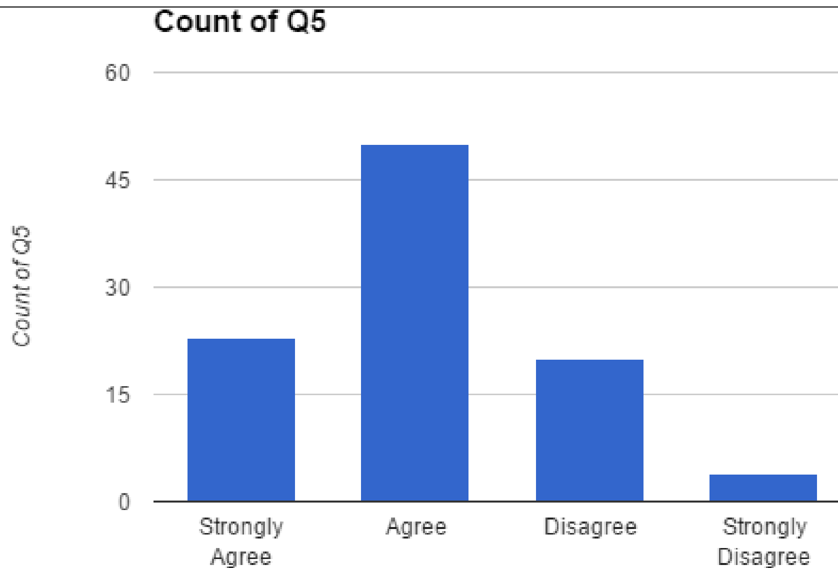


Fig. 4.11
Frequency distribution of question (5)

Key informant answers to Question (6) "Quality assurance team should be formulated."

The frequencies and the percentage of the answers for this question were as shown in table (4.12) and figure (4.12), which show that the number of employees who they strongly agree with it is (27) with a percentage of (27.8%) , while the number of employees who agree with it is (44) with a percentage of (45.4%) , and the number of employee who they disagree with it is (26) with a percentage of (26.8%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.12
Frequency distribution of question (6)

Answer	Number	Percentage
Strongly Agree	27	27.8%
Agree	44	45.4%
Disagree	26	26.8%
Strongly Disagree	0	0%
Total	97	100%

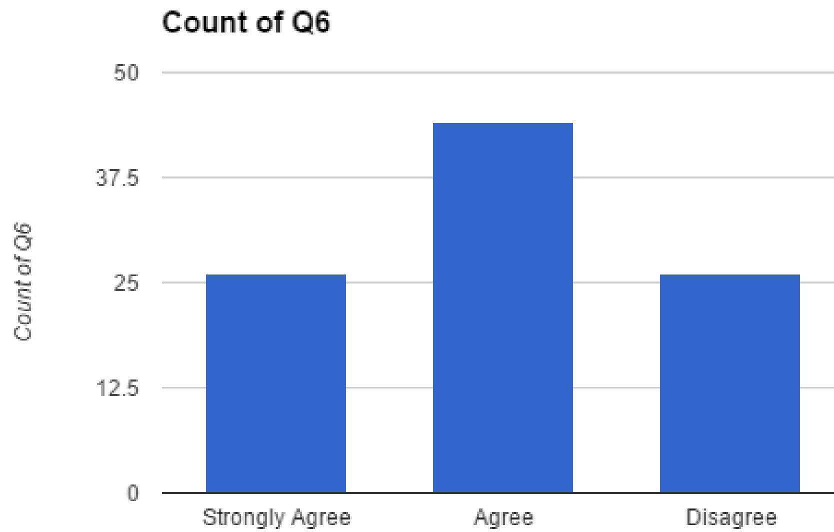


Fig. 4.12
Frequency distribution of question (6)

Table 4.13
Results of T-test to know the impact of applying total quality management on the corrective maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
1	Using tools of TQM Cause and Effect, Fishbone and Ishikawa Diagram help to find the root causes of the problems	2.8041	0.57080	Medium	13.875	0.000
2	Records kept for future decision making will help in dealing with similar events	3.0000	0.77728	High	12.671	0.000
3	Adequate ventilation, first aid and Personal Protective items should be available.	2.9175	0.78621	Medium	11.494	0.000
4	Frequency of corrective operation (rework) should be noted as performance index	2.8041	0.71646	Medium	11.054	0.000
5	Delegation of responsibility is essential for over or overall operation success.	2.9485	0.78224	Medium	11.942	0.000
6	Quality assurance team should be formulated.	3.0103	0.74295	High	13.393	0.000
	Total field	**2.9140**	**0.73481**	**Medium**	**12.251**	0.000

Table (4.13) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying total quality management on the corrective maintenance, has reached (2.9140) with a standard deviation of (0.73481) which represents a medium degree of estimation, As all the paragraphs in the table benediction a high and medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism form and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying total quality management on the corrective maintenance.

Results related to the second hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (communication-oriented PCIS) to improve the level of maintenance dimension (Corrective Maintenance).

Key informant answers to Question (7) "Recording the poor quality rate of equipment will avoid any unexpected failure."

The frequencies and the percentage of the answers for this question were as shown in table (4.14) and figure (4.13), which show that the number of employees who they strongly agree with it is (22) with a percentage of (22.7%) , while the number of employees who agree with it is (47) with a percentage of (48.5%) , and the number of employee who they disagree with it is (28) with a percentage of (28.9%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.14
Frequency distribution of question (7)

Answer	Number	Percentage
Strongly Agree	22	22.7%
Agree	47	48.5%
Disagree	28	28.9%
Strongly Disagree	0	0%
Total	97	100%

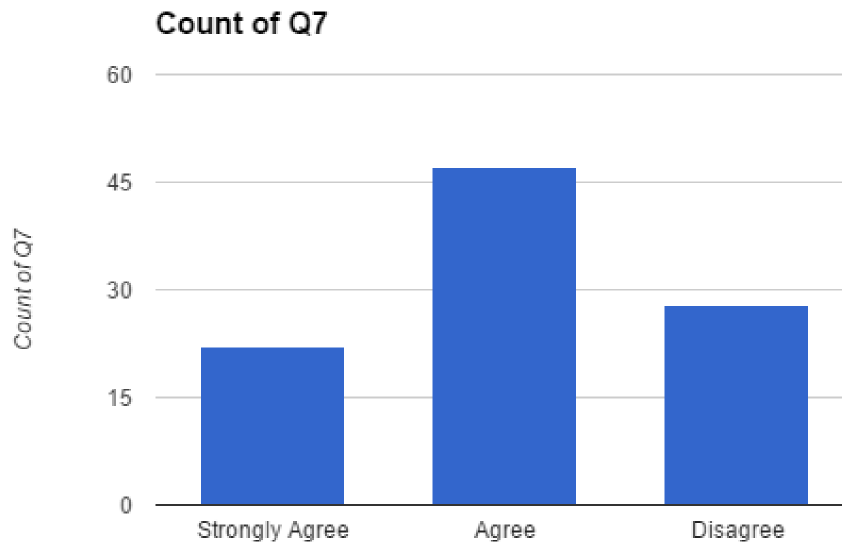


Fig. 4.13
Frequency distribution of question (7)

Key informant answers to Question (8) "Estimating the time of repairing works will reduce the unsold power"

The frequencies and the percentage of the answers for this question were as shown in table (4.15) and figure (4.14), which show that the number of employees who they strongly agree with it is (20) with a percentage of (20.6%) , while the number of employees who agree with it is (59) with a percentage of (60.8%) , and the number of employee who they disagree with it is (18) with a percentage of (18.6%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.15
Frequency distribution of question (8)

Answer	Number	Percentage
Strongly Agree	20	20.6%
Agree	59	60.8%
Disagree	18	18.6%
Strongly Disagree	0	0%
Total	97	100%

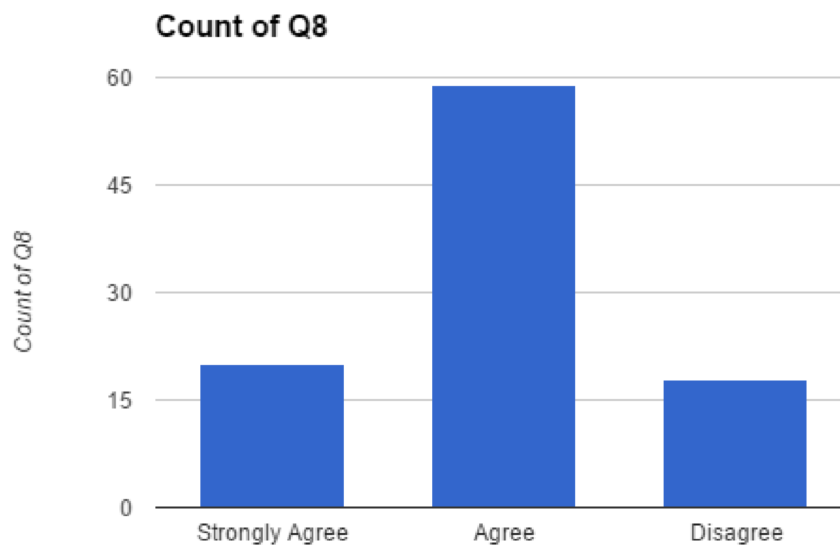


Fig. 4.14
Frequency distribution of question (8)

Key informant answers to Question (9) "determining the needed spare parts will reduce the repairing time"

The frequencies and the percentage of the answers for this question were as shown in table (4.16) and figure (4.15), which show that the number of employees who they strongly agree with it is (29) with a percentage of (29.9%) , while the number of employees who agree with it is (54) with a percentage of (55.7%) , and the number of employee who they disagree with it is (14) with a percentage of (14.4%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.16
Frequency distribution of question (9)

Answer	Number	Percentage
Strongly Agree	29	29.9%
Agree	54	55.7%
Disagree	14	14.4%
Strongly Disagree	0	0%
Total	97	100%

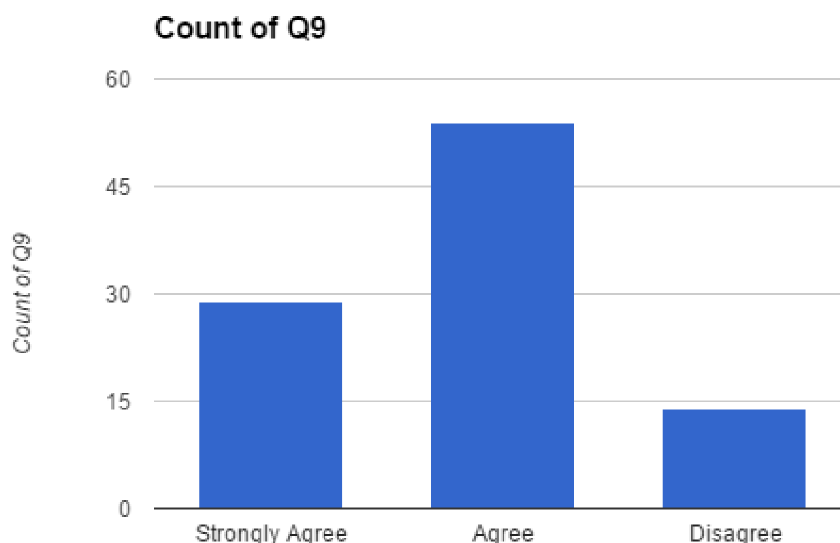


Fig. 4.15
Frequency distribution of question (9)

Key informant answers to Question (10) "Computer software helps in measuring of Maintenance System performance"

The frequencies and the percentage of the answers for this question were as shown in table (4.17) and figure (4.16), which show that the number of employees who they strongly agree with it is (32) with a percentage of (33.0%) , while the number of employees who agree with it is (50) with a percentage of (51.5%) , and the number of employee who they disagree with it is (15) with a percentage of (15.5%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.17
Frequency distribution of question (10)

Answer	Number	Percentage
Strongly Agree	32	33.0%
Agree	50	51.5%
Disagree	15	15.5%
Strongly Disagree	0	0%
Total	97	100%

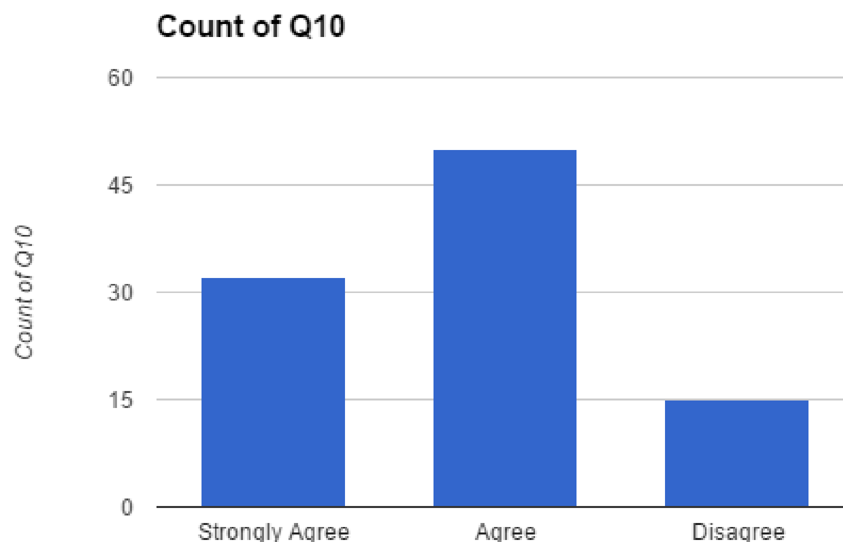


Fig. 4.16
Frequency distribution of question (10)

Key informant answers to Question (11) "Publish Laws and rules of maintenance on local network will make it easy access for the employee"

The frequencies and the percentage of the answers for this question were as shown in table (4.18) and figure (4.17), which show that the number of employees who they strongly agree with it is (31) with a percentage of (32.0%) , while the number of employees who agree with it is (32) with a percentage of (33.0%) , and the number of employee who they disagree with it is (34) with a percentage of (35.0%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.18
Frequency distribution of question (11)

Answer	Number	Percentage
Strongly Agree	31	32.0%
Agree	32	330%
Disagree	34	35.0%
Strongly Disagree	0	0%
Total	97	100%

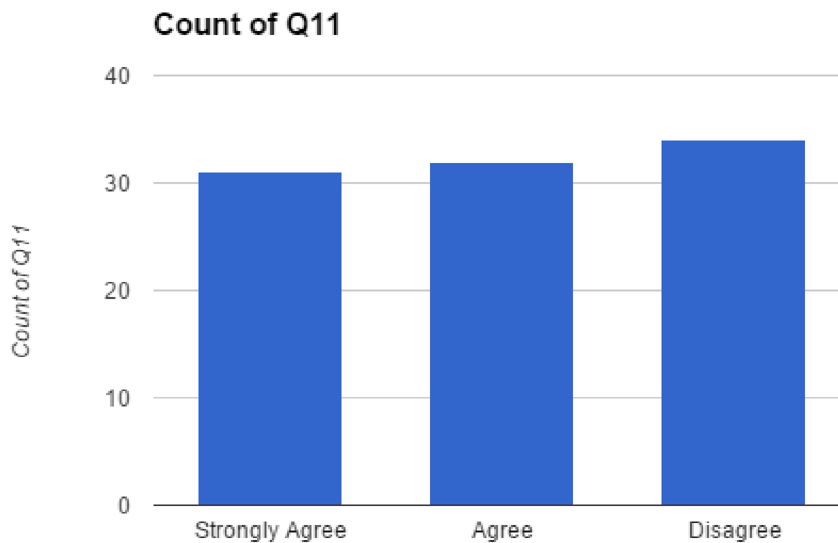


Fig. 4.17
Frequency distribution of question (11)

Key informant answers to Question (12) "Using Electronic schemes will make it easy to track the problem which will reduce the interruption time"

The frequencies and the percentage of the answers for this question were as shown in table (4.19) and figure (4.18), which show that the number of employees who they strongly agree with it is (27) with a percentage of (27.8%) , while the number of employees who agree with it is (44) with a percentage of (45.4%) , and the number of employee who they disagree with it is (26) with a percentage of (26.8%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.19
Frequency distribution of question (12)

Answer	Number	Percentage
Strongly Agree	27	27.8%
Agree	44	45.4%
Disagree	26	26.8%
Strongly Disagree	0	0%
Total	97	100%

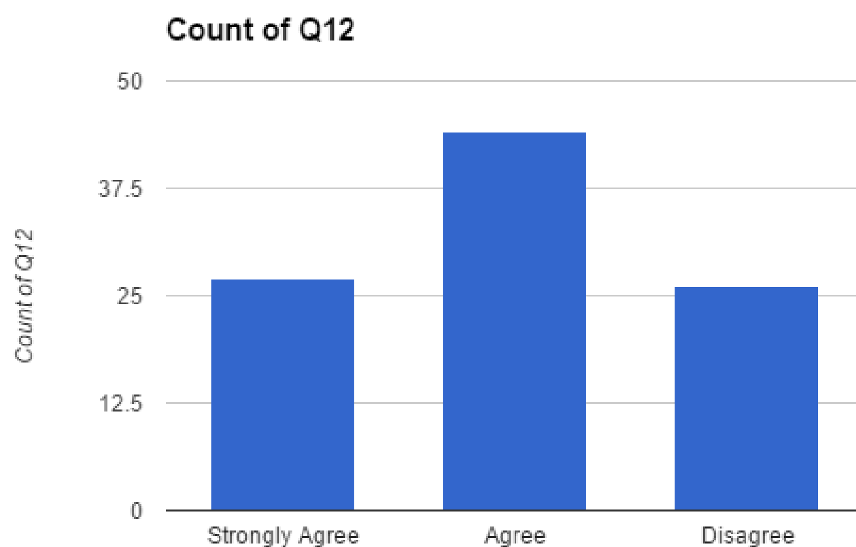


Fig. 4.18
Frequency distribution of question (12)

Table 4.20
Results of T-test to know the impact of applying communication-oriented PCIS on the corrective maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
7	Recording the poor quality rate of equipment will avoid any unexpected failure	2.9381	0.71900	Medium	12.851	0.000
8	Estimating the time of repairing works will reduce the unsold power	3.0206	0.62881	High	15.986	0.000
9	determining the needed spare parts will reduce the repairing time	3.1546	0.65096	High	17.469	0.000
10	Computer software helps in measuring of Maintenance System performance	3.1753	0.67716	High	17.093	0.000
11	Publish Laws and rules of maintenance on local network will make it easy access for the employee	2.9691	0.82226	Medium	11.607	0.000
12	Using Electronic schemes will make it easy to track the problem which will reduce the interruption time	3.0103	0.74295	High	13.393	0.000
	Total field	**3.0445**	**0.71237**	**High**	**14.441**	**0.000**

Table (4.20) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying communication-oriented PCIS on the corrective maintenance, has reached (3.0445) with a standard deviation of (0.71237) which represents a high degree of estimation, as all the paragraphs in the table benediction a high an medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism image and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying communication-oriented PCIS on the corrective maintenance.

Results related to the third hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (Total Quality Management TQM) to improve the level of maintenance dimension (Predictive Maintenance).

Key informant answers to Question (13) “Using the Tool of TQM “Checklist” will reduce the human Errors while doing the Predictive maintenance”

The frequencies and the percentage of the answers for this question were as shown in table (4.21) and figure (4.19), which show that the number of employees who they strongly agree with it is (19) with a percentage of (19.6%) , while the number of employees who agree with it is (53) with a percentage of (54.6%) , and the number of employee who they disagree with it is (21) with a percentage of (21.6%) , and the number of employee who they strongly disagree with it is (4) with a percentage of (4.2%).

Table 4.21
Frequency distribution of question (13)

Answer	Number	Percentage
Strongly Agree	19	19.6%
Agree	53	54.6%
Disagree	21	21.6%
Strongly Disagree	4	4.2%
Total	97	100%

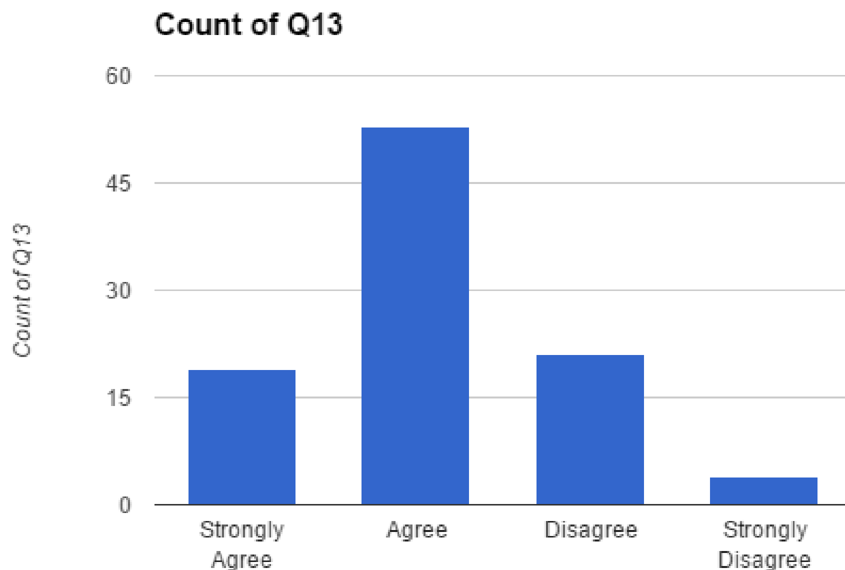


Fig. 4.19
Frequency distribution of question (13)

Key informant answers to Question (14) "To ensure clients demand and high quality standards, the supplied materials are examined before installation"

The frequencies and the percentage of the answers for this question were as shown in table (4.22) and figure (4.20), which show that the number of employees who they strongly agree with it is (20) with a percentage of (20.6%) , while the number of employees who agree with it is (57) with a percentage of (58.7%) , and the number of employee who they disagree with it is (12) with a percentage of (12.4%) , and the number

of employee who they strongly disagree with it is (8) with a percentage of (8.2%).

Table 4.22
Frequency distribution of question (14)

Answer	Number	Percentage
Strongly Agree	20	20.6%
Agree	57	58.8%
Disagree	12	12.4%
Strongly Disagree	8	8.2%
Total	97	100%

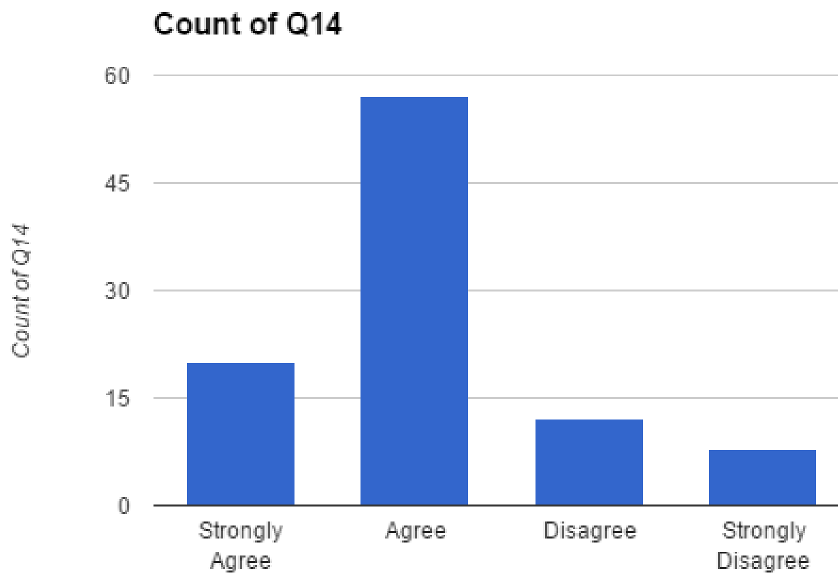


Fig. 4.20
Frequency distribution of question (14)

Key informant answers to Question (15) "Periodic measurement of maintenance quality management must be done"

The frequencies and the percentage of the answers for this question were as shown in table (4.23) and figure (4.21), which show that the number of employees who they strongly agree with it is (26) with a percentage of (26.8%) , while the number of employees who agree with it is (59) with a percentage of (60.8%) , and the number of employee who they disagree with it is (12) with a percentage of (12.4%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.23
Frequency distribution of question (15)

Answer	Number	Percentage
Strongly Agree	26	26.8%
Agree	59	60.8%
Disagree	12	12.4%
Strongly Disagree	0	0%
Total	97	100%

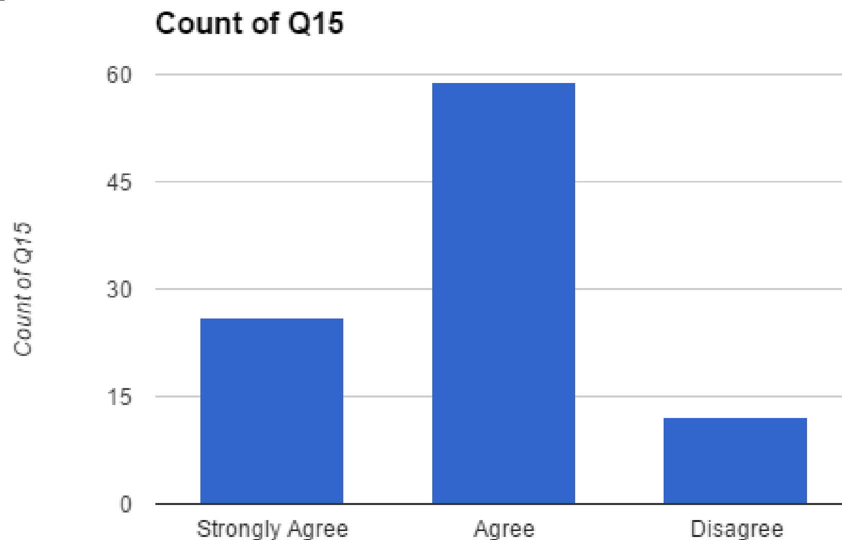


Fig. 4.21
Frequency distribution of question (15)

Key informant answers to Question (16) "Conventional method of detecting faults should be in place"

The frequencies and the percentage of the answers for this question were as shown in table (4.24) and figure (4.22), which show that the number of employees who they strongly agree with it is (14) with a percentage of (14.4%) , while the number of employees who agree with it is (50) with a percentage of (51.5%) , and the number of employee who they disagree with it is (33) with a percentage of (34.0%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.24
Frequency distribution of question (16)

Answer	Number	Percentage
Strongly Agree	14	14.4%
Agree	50	51.5%
Disagree	33	34.0%
Strongly Disagree	0	0%
Total	97	100%

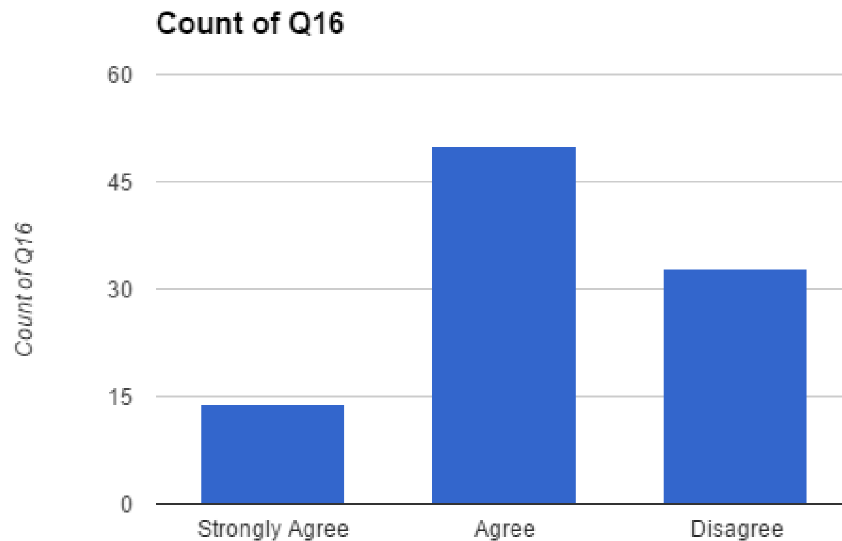


Fig. 4.22
Frequency distribution of question (16)

Key informant answers to Question (17) "Personnel should be taught fault recognition techniques"

The frequencies and the percentage of the answers for this question were as shown in table (4.25) and figure (4.23), which show that the number of employees who they strongly agree with it is (30) with a percentage of (30.9%) , while the number of employees who agree with it is (49) with a percentage of (50.5%) , and the number of employee who they disagree with it is (18) with a percentage of (18.6%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.25
Frequency distribution of question (17)

Answer	Number	Percentage
Strongly Agree	30	30.9%
Agree	49	50.5%
Disagree	18	18.6%
Strongly Disagree	0	0%
Total	97	100%

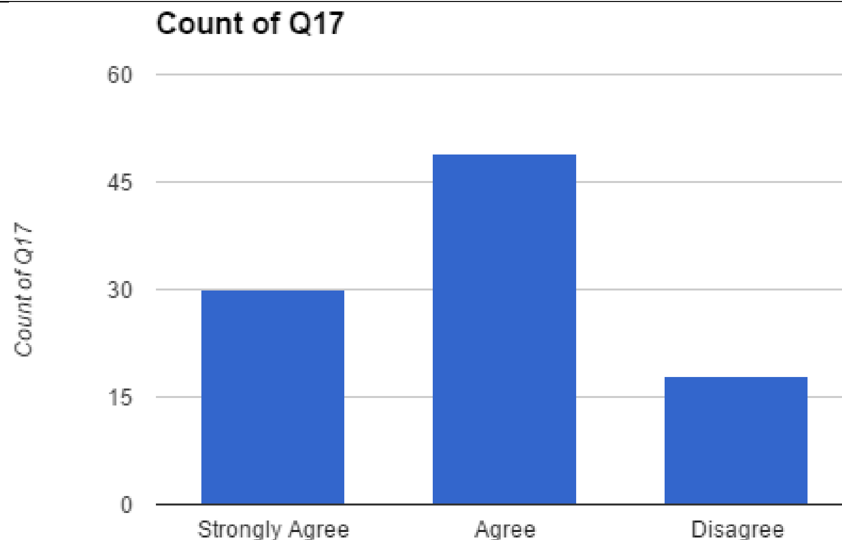


Fig. 4.23
Frequency distribution of question (17)

Key informant answers to Question (18) "Period retrospective check on successful implementation essential."

The frequencies and the percentage of the answers for this question were as shown in table (4.26) and figure (4.24), which show that the number of employees who they strongly agree with it is (23) with a percentage of (23.7%) , while the number of employees who agree with it is (51) with a percentage of (52.6%) , and the number of employee who they disagree with it is (23) with a percentage of (23.7%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.26
Frequency distribution of question (18)

Answer	Number	Percentage
Strongly Agree	23	23.7%
Agree	51	52.6%
Disagree	23	23.7%
Strongly Disagree	0	0%
Total	97	100%

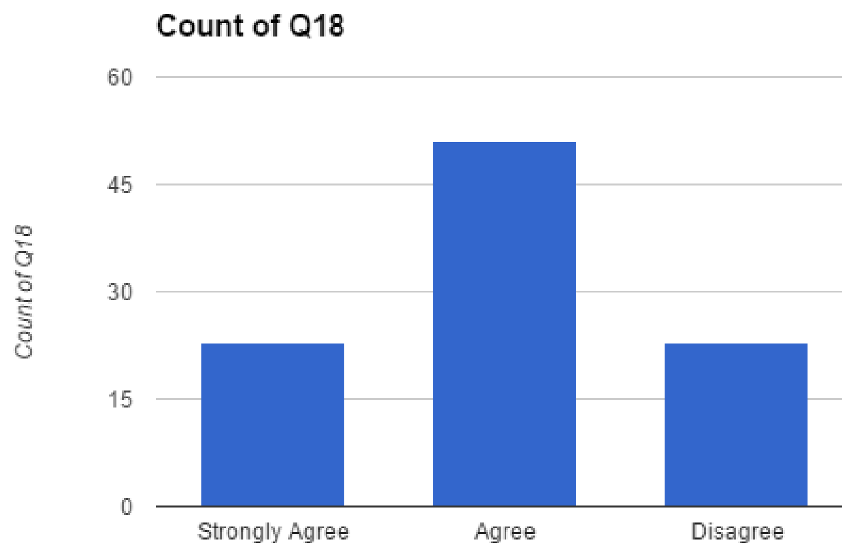


Fig. 4.24
Frequency distribution of question (18)

Table 4.27
Results of T-test to know the impact of applying total quality management on the predictive maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
13	Using the Tool of TQM "Checklist' will reduce the human Errors while doing the Predictive maintenance	2.8969	0.75670	Medium	11.674	0.000
14	To ensure clients demand and high quality standards, the supplied materials are examined before installation	2.9175	0.81228	Medium	11.125	0.000
15	Periodic measurement of maintenance quality management must be done	3.1443	0.61220	High	18.410	0.000
16	Conventional method of detecting faults should be in place	2.8041	0.67143	Medium	11.795	0.000
17	Personnel should be taught fault recognition techniques	3.1237	0.69609	High	15.899	0.000
18	Period retrospective check on successful implementation essential.	3.0000	0.69222	High	14.228	0.000
	Total field	**2.9811**	**0.71713**	**Medium**	**13.474**	0.000

Table (4.27) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying total quality management on the predictive maintenance, has reached (2.9811) with a standard deviation of (0. 71713) which represents a medium degree of estimation, As all the paragraphs in the table benediction a high and medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism image and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying total quality management on the predictive maintenance.

Results related to the fourth hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (communication-oriented PCIS) to improve the level of maintenance dimension (Predictive Maintenance).

Key informant answers to Question (19) "provide failure historical data to predict where and when failure will happen, will reduce interrupting time."

The frequencies and the percentage of the answers for this question were as shown in table (4.28) and figure (4.25), which show that the number of employees who they strongly agree with it is (15) with a percentage of (15.5%) , while the number of employees who agree with it is (41) with a percentage of (42.3%) , and the number of employee who they disagree with it is (22) with a percentage of (22.7%) , and the number of employee who they strongly disagree with it is (19) with a percentage of (19.6%).

Table 4.28
Frequency distribution of question (19)

Answer	Number	Percentage
Strongly Agree	15	15.5%
Agree	41	42.3%
Disagree	22	22.7%
Strongly Disagree	19	19.6%
Total	97	100%

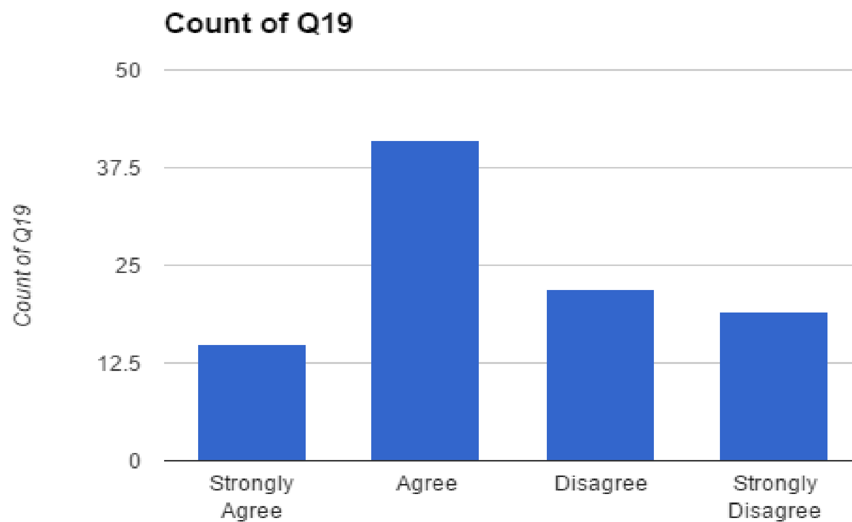


Fig. 4.25
Frequency distribution of question (19)

Key informant answers to Question (20) "Equipment downtime is tracked and reviewed periodically will improve the maintenance efficiency."

The frequencies and the percentage of the answers for this question were as shown in table (4.28) and figure (4.25), which show that the number of employees who they strongly agree with it is (24) with a percentage of (24.7%) , while the number of employees who agree with it is (44) with a percentage of (45.4%) , and the number of employee who they disagree with it is (17) with a percentage of (17.5%) , and the number

of employee who they strongly disagree with it is (12) with a percentage of (12.4%).

Table 4.29
Frequency distribution of question (20)

Answer	Number	Percentage
Strongly Agree	24	24.7%
Agree	44	45.4%
Disagree	17	17.5%
Strongly Disagree	12	12.4%
Total	97	100%

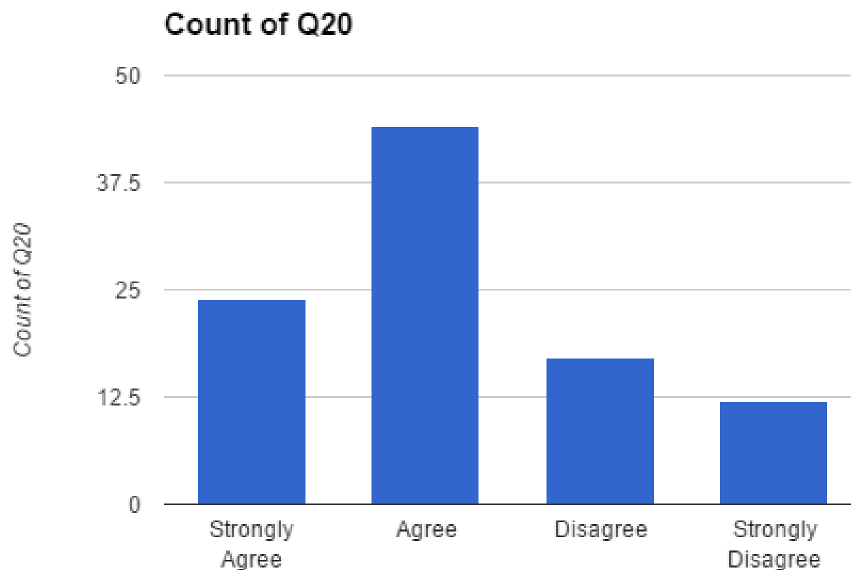


Fig. 4.26
Frequency distribution of question (20)

Key informant answers to Question (21) "Monitoring and controlling of machines will reduce the interruption time."

The frequencies and the percentage of the answers for this question were as shown in table (4.29) and figure (4.26), which show that the number of employees who they strongly agree with it is (22) with a percentage of (22.7%) , while the number of employees who agree with it is (38) with a percentage of (39.2%) , and the number of employee who they disagree with it is (24) with a percentage of (24.7%) , and the number of employee who they strongly disagree with it is (11) with a percentage of (11.3%).

Table 4.30
Frequency distribution of question (21)

Answer	Number	Percentage
Strongly Agree	22	22.7%
Agree	38	39.2%
Disagree	24	24.7%
Strongly Disagree	13	13.3%
Total	97	100%

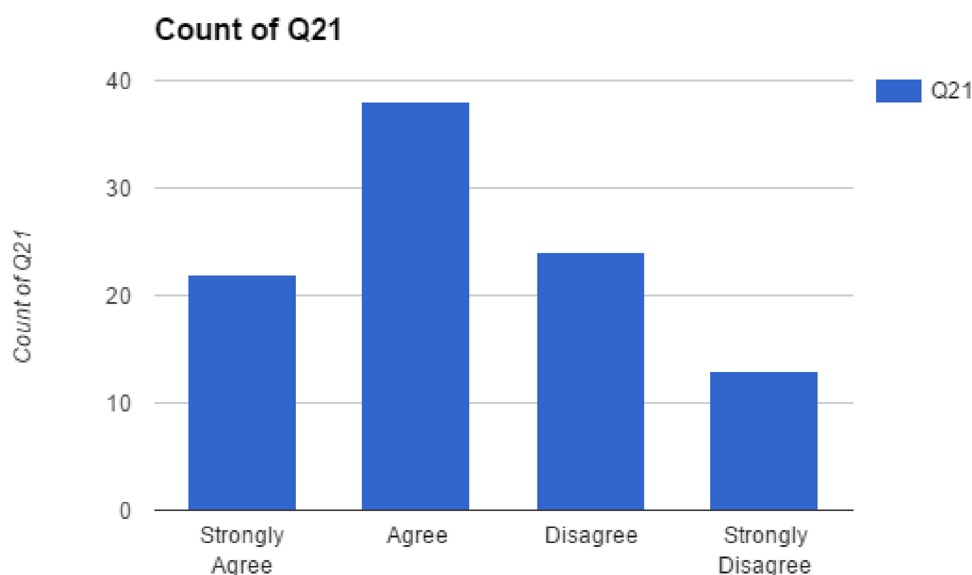


Fig. 4.27
Frequency distribution of question (21)

Key informant answers to Question (22) "Computer software will help in finding the data of every unit or equipment"

The frequencies and the percentage of the answers for this question were as shown in table (4.30) and figure (4.27), which show that the number of employees who they strongly agree with it is (25) with a percentage of (25.8%) , while the number of employees who agree with it is (40) with a percentage of (41.2%) , and the number of employee who they disagree with it is (21) with a percentage of (21.6%) , and the number of employee who they strongly disagree with it is (11) with a percentage of (11.3%).

Table 4.31
Frequency distribution of question (22)

Answer	Number	Percentage
Strongly Agree	25	25.8%
Agree	40	41.2%
Disagree	21	21.6%
Strongly Disagree	11	11.4%
Total	97	100%

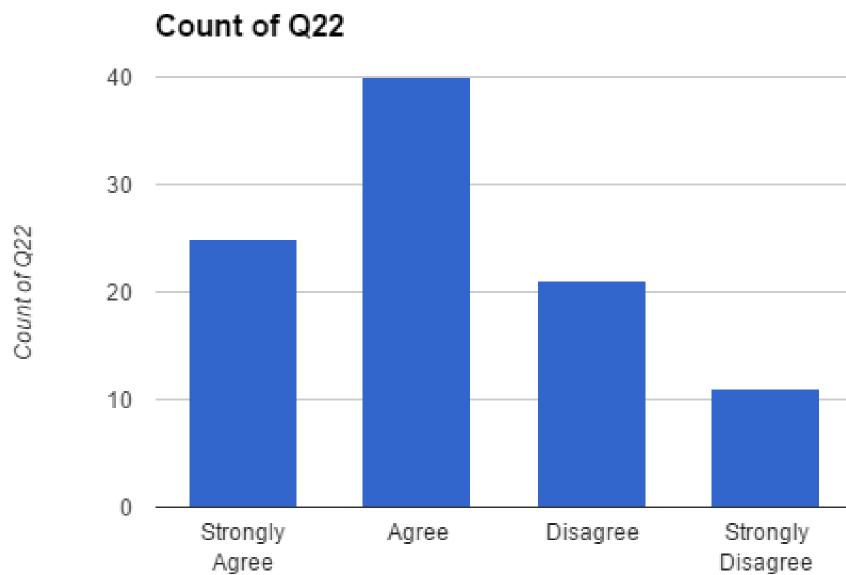


Fig. 4.28
Frequency distribution of question (22)

Key informant answers to Question (23) "Applying life cycle curves to modify long range projections and improve the maintenance activities"

The frequencies and the percentage of the answers for this question were as shown in table (4.32) and figure (4.29), which show that the number of employees who they strongly agree with it is (21) with a percentage of (21.6%) , while the number of employees who agree with it is (38) with a percentage of (39.2%) , and the number of employee who they disagree with it is (25) with a percentage of (25.8%) , and the number of employee who they strongly disagree with it is (13) with a percentage of (13.4%).

Table 4.32 Frequency distribution of question (23)

Answer	Number	Percentage
Strongly Agree	21	21.6%
Agree	38	39.2%
Disagree	25	25.8%
Strongly Disagree	13	13.4%
Total	97	100%

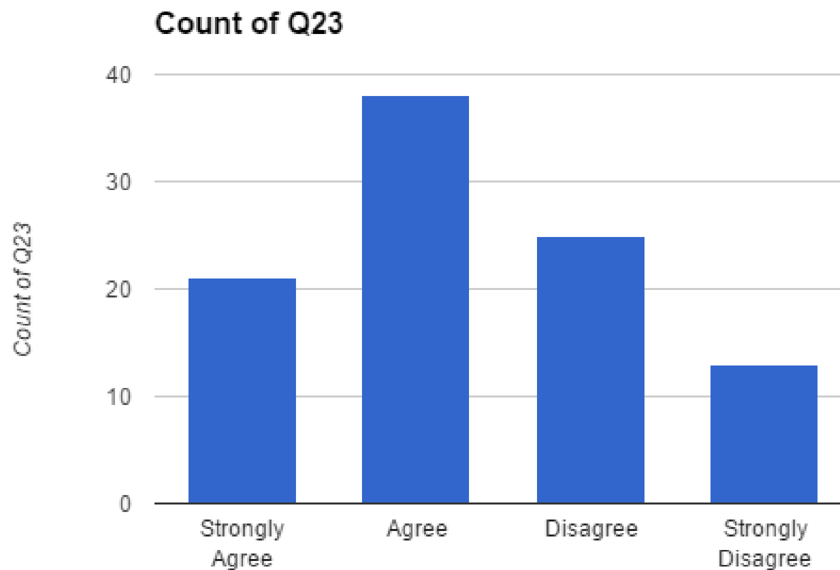


Fig. 4.29

Frequency distribution of question (23)

Key informant answers to Question (24) "Using software simulations will help to predict the failure before it happen"

The frequencies and the percentage of the answers for this question were as shown in table (4.33) and figure (4.30), which show that the number of employees who they strongly agree with it is (22) with a percentage of (22.7%) , while the number of employees who agree with it is (37) with a percentage of (38.1%) , and the number of employee who they disagree with it is (28) with a percentage of (28.9%) , and the number of employee who they strongly disagree with it is (10) with a percentage of (10.3%).

Table 4.33
Frequency distribution of question (24)

Answer	Number	Percentage
Strongly Agree	22	22.7%
Agree	37	38.1%
Disagree	28	28.9%
Strongly Disagree	10	10.3%
Total	97	100%

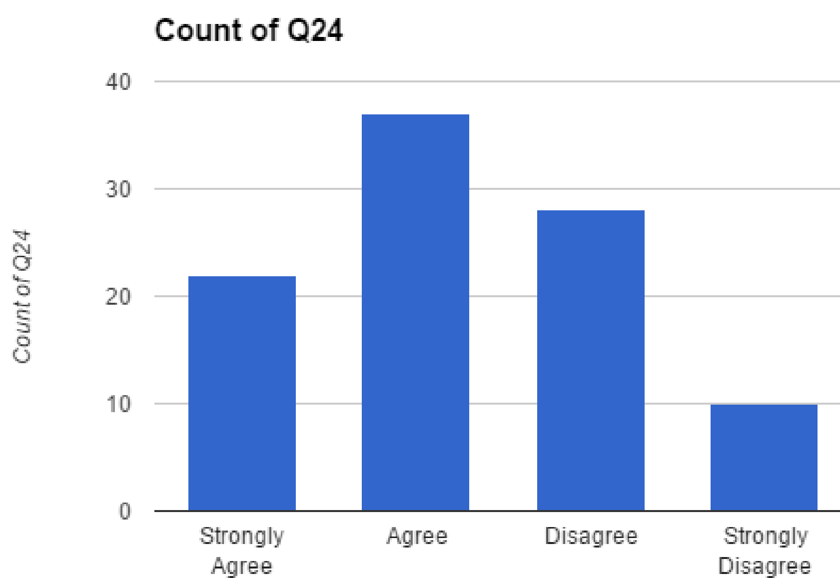


Fig. 4.30
Frequency distribution of question (24)

Table 4.34
Results of T-test to know the impact of applying communication-oriented PCIS on the predictive maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
19	provides failure historical data to predict where and when failure will happen will reduce interrupting time	2.5361	0.97960	Medium	5.390	0.000
20	Equipment downtime is tracked and reviewed periodically will improve the maintenance efficiency	2.8247	0.94660	Medium	8.581	0.000
21	Monitoring and controlling of machines will reduce the interruptior time	2.7113	0.96780	Medium	7.239	0.000
22	Computer software will help in finding the data of every unit or equipment	2.8144	0.95011	Medium	8.442	0.000
23	Applying life cycle curves to modify long range projections and improve the maintenance activities	2.6907	0.96134	Medium	7.076	0.000
24	Using software simulations will help to predict the failure before it happen	2.7320	0.93000	Medium	7.752	0.000
	Total field	**2.7182**	**0.95671**	**Medium**	**7.394**	0.000

Table (4.34) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying communication-oriented PCIS on the predictive maintenance, has reached (2.7182) with a standard deviation of (0.95671) which represents a medium degree of estimation, as all the paragraphs in the table benediction a Medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism image and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying communication-oriented PCIS t on the predictive maintenance.

Results related to the fifth hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (Total Quality Management TQM)

to improve the level of maintenance dimension (Preventive Maintenance).

Key informant answers to Question (25) "Using the Tool of TQM "Checklist" will reduce the human Errors while doing the preventive maintenance"

The frequencies and the percentage of the answers for this question were as shown in table (4.35) and figure (4.31), which show that the number of employees who they strongly agree with it is (19) with a percentage of (19.6%) , while the number of employees who agree with it is (61) with a percentage of (62.9%) , and the number of employee who they disagree with it is (16) with a percentage of (16.5%) , and the number of employee who they strongly disagree with it is (1) with a percentage of (1.0%).

Table 4.35
Frequency distribution of question (25)

Answer	Number	Percentage
Strongly Agree	19	19.6%
Agree	61	62.9%
Disagree	16	16.5%
Strongly Disagree	1	1.0%
Total	97	100%

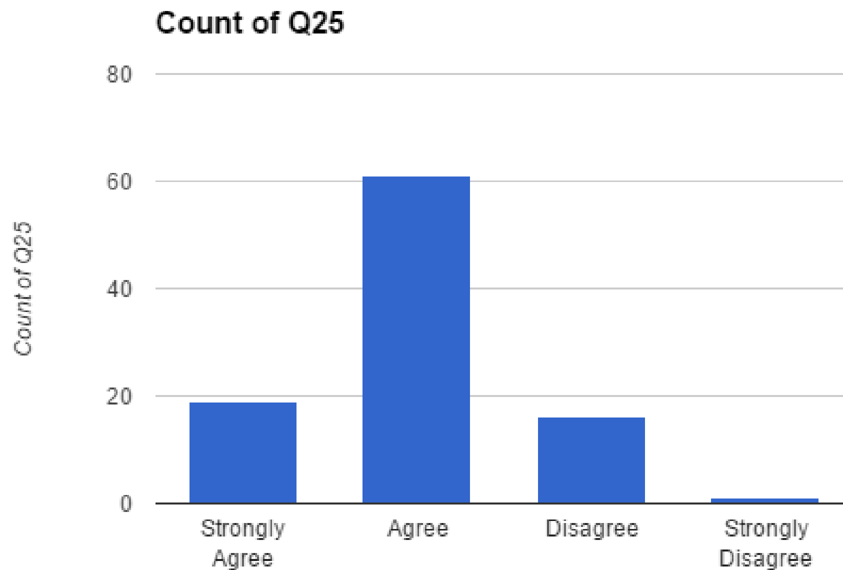


Fig. 4.31
Frequency distribution of question (25)

Key informant answers to Question (26) "Involving Technical Employee in the preventive maintenance planning process will improve the maintenance activities"

The frequencies and the percentage of the answers for this question were as shown in table (4.36) and figure (4.32), which show that the

number of employees who they strongly agree with it is (26) with a percentage of (26.8%) , while the number of employees who agree with it is (58) with a percentage of (59.8%) , and the number of employee who they disagree with it is (11) with a percentage of (11.3%) , and the number of employee who they strongly disagree with it is (2) with a percentage of (2.1%).

Table 4.36
Frequency distribution of question (26)

Answer	Number	Percentage
Strongly Agree	26	26.8%
Agree	58	59.8%
Disagree	11	11.3%
Strongly Disagree	2	2.1%
Total	97	100%

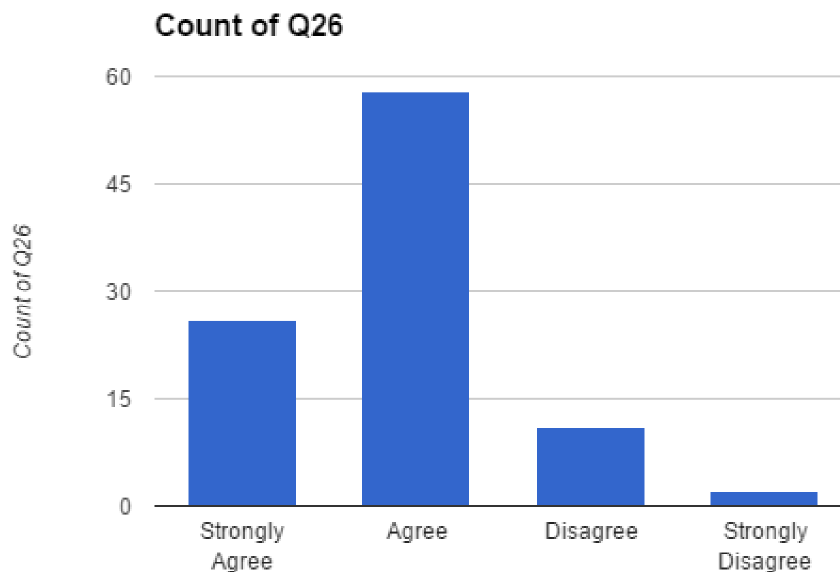


Fig. 4.32
Frequency distribution of question (26)

Key informant answers to Question (27) "Standard of works and operational quality should be clearly communicated"

The frequencies and the percentage of the answers for this question were as shown in table (4.37) and figure (4.33), which show that the number of employees who they strongly agree with it is (20) with a percentage of (20.6%) , while the number of employees who agree with it is (53) with a percentage of (54.6%) , and the number of employee who they disagree with it is (22) with a percentage of (22.7%) , and the number of employee who they strongly disagree with it is (2) with a percentage of (2.1%).

Table 4.37
Frequency distribution of question (27)

Answer	Number	Percentage
Strongly Agree	20	20.6%
Agree	53	54.6%
Disagree	22	22.7%
Strongly Disagree	2	2.1%
Total	97	100%

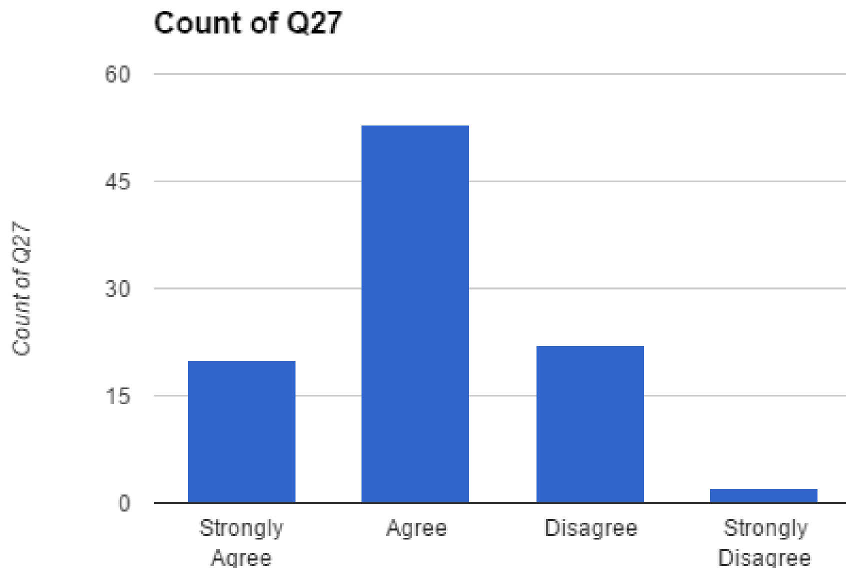


Fig. 4.33
Frequency distribution of question (27)

Key informant answers to Question (28) "Management should convey meeting on quality in maintenance issue periodically"

The frequencies and the percentage of the answers for this question were as shown in table (4.38) and figure (4.34), which show that the number of employees who they strongly agree with it is (19) with a percentage of (19.6%) , while the number of employees who agree with it is (62) with a percentage of (63.9%) , and the number of employee who they disagree with it is (14) with a percentage of (14.4%) , and the number of employee who they strongly disagree with it is (2) with a percentage of (2.1%).

Table 4.38
Frequency distribution of question (28)

Answer	Number	Percentage
Strongly Agree	19	19.6%
Agree	62	63.9%
Disagree	14	14.4%
Strongly Disagree	2	2.1%
Total	97	100%

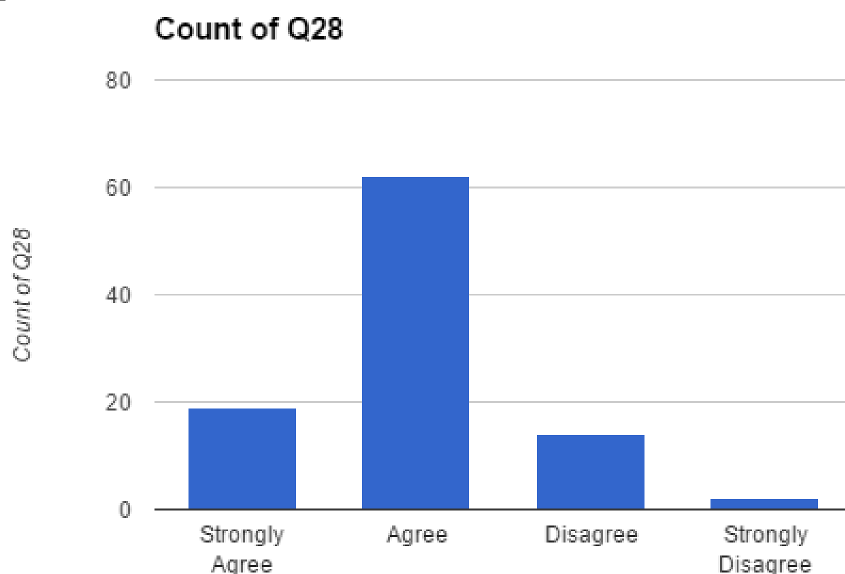


Fig. 4.34
Frequency distribution of question (28)

Key informant answers to Question (29) "There should be budget for preventive maintenance."

The frequencies and the percentage of the answers for this question were as shown in table (4.39) and figure (4.35), which show that the number of employees who they strongly agree with it is (19) with a percentage of (19.6%) , while the number of employees who agree with it is (45) with a percentage of (46.4%) , and the number of employee who they disagree with it is (31) with a percentage of (32.0%) , and the number of employee who they strongly disagree with it is (2) with a percentage of (2.1%).

Table 4.39
Frequency distribution of question (29)

Answer	Number	Percentage
Strongly Agree	19	19.6%
Agree	45	46.4%
Disagree	31	32.0%
Strongly Disagree	2	2.1%
Total	97	100%

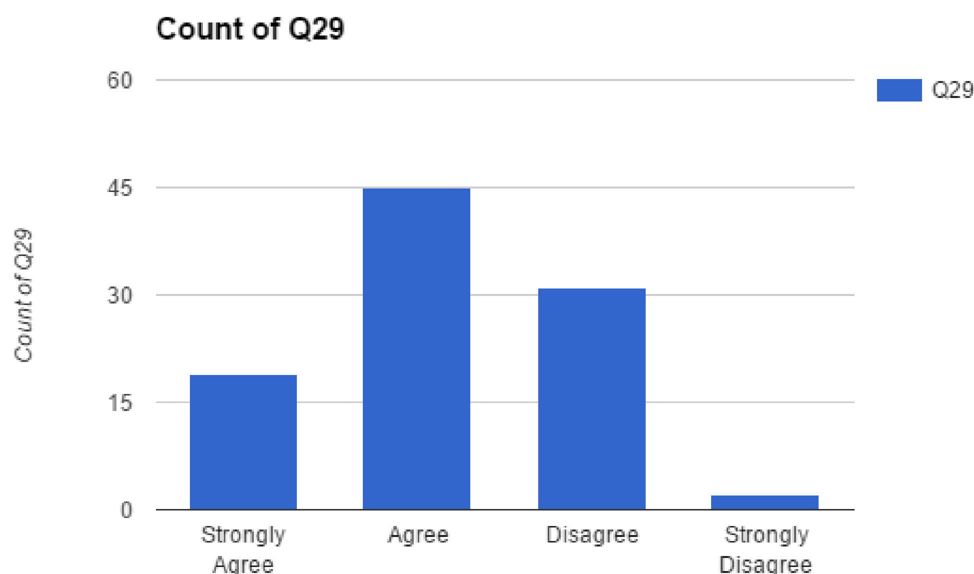


Fig. 4.35
Frequency distribution of question (29)

Key informant answers to Question (30) "The maintenance time should be Suitable for the customers."

The frequencies and the percentage of the answers for this question were as shown in table (4.40) and figure (4.36), which show that the number of employees who they strongly agree with it is (12) with a percentage of (12.4%) , while the number of employees who agree with it is (67) with a percentage of (69.1%) , and the number of employee who they disagree with it is (15) with a percentage of (15.5%) , and the number of employee who they strongly disagree with it is (3) with a percentage of (3.1%).

Table 4.40
Frequency distribution of question (30)

Answer	Number	Percentage
Strongly Agree	12	12.4%
Agree	67	69.1%
Disagree	15	15.5%
Strongly Disagree	3	3.1%
Total	97	100%

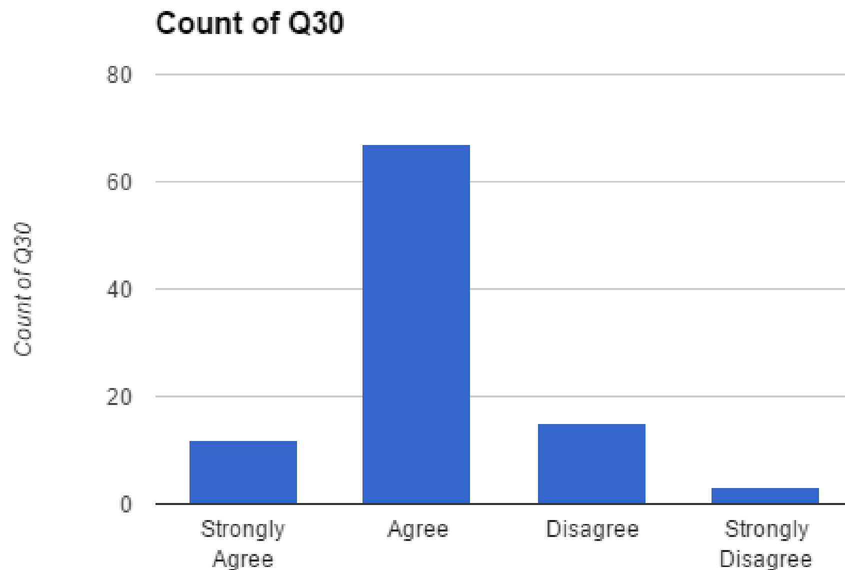


Fig. 4.36
Frequency distribution of question (30)

Key informant answers to Question (31) "The Company should have plan for the preventive maintenance over the year."

The frequencies and the percentage of the answers for this question were as shown in table (4.41) and figure (4.37), which show that the number of employees who they strongly agree with it is (22) with a percentage of (22.7%) , while the number of employees who agree with it is (51) with a percentage of (52.6%) , and the number of employee who they disagree with it is (22) with a percentage of (22.7%) , and the number of employee who they strongly disagree with it is (2) with a percentage of (2.1%).

Table 4.41
Frequency distribution of question (31)

Answer	Number	Percentage
Strongly Agree	22	22.7%
Agree	51	52.6%
Disagree	22	22.7%
Strongly Disagree	2	2.1%
Total	97	100%

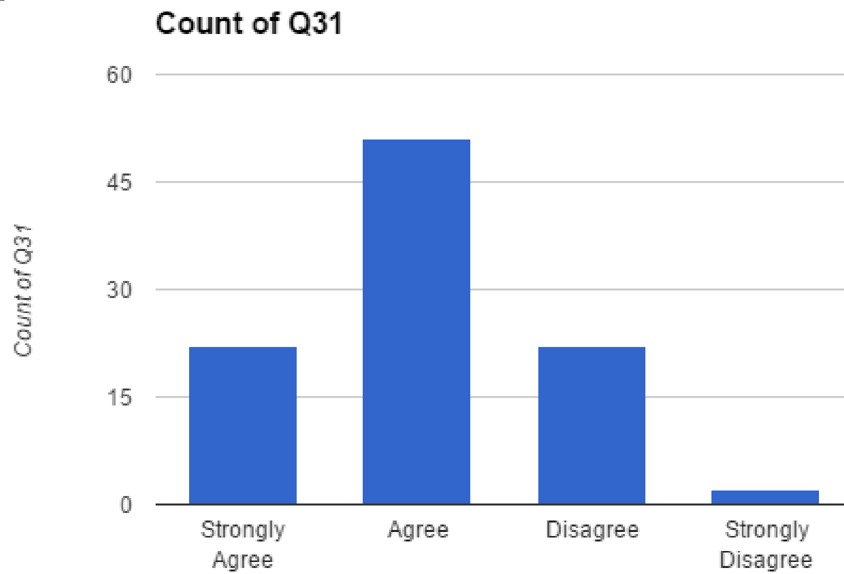


Fig. 4.37
Frequency distribution of question (31)

Table 4.42
Results of T-test to know the impact of applying total quality management on the preventive maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
25	Using the Tool of TQM "Checklist' will reduce the human Errors while doing the preventive maintenance	3.0103	0.63729	High	15.614	0.000
26	Involving Technical Employee in the preventive maintenance planning process will improve the maintenance activities	3.1134	0.67510	High	16.243	0.000
27	Standard of works and operational quality should be clearly communicated	2.9381	0.71900	Medium	12.851	0.000
28	Management should convey meeting on quality in maintenance issue periodically.	3.0103	0.65343	High	15.228	0.000
29	There should be budget for preventive maintenance.	2.8351	0.75939	Medium	10.830	0.000
30	The maintenance time should be Suitable for the customers	2.9072	0.63052	Medium	14.171	0.000
31	The company should have plan for the preventive maintenance over the year	2.9588	0.73481	Medium	12.851	0.000
	Total field	**2.9676**	**0.69052**	**Medium**	**13.801**	0.000

Table (4.42) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying total quality management on the preventive maintenance, has reached (2.9676) with a standard deviation of (0.69052) which represents a medium degree of estimation, As all the paragraphs in the table benediction a high and medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism image and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying total quality management on the preventive maintenance.

Results related to the sixth hypotheses: There is no impact with a statistical significant at the level of significance ($\alpha \leq 0.05$) of using production management technique (communication-oriented PCIS) to improve the level of maintenance dimension (Predictive Maintenance).

Key informant answers to Question (32) "Performing maintenance tasks based on statistical modeling of failure data will improve maintenance efficiency."

The frequencies and the percentage of the answers for this question were as shown in table (4.43) and figure (4.38), which show that the number of employees who they strongly agree with it is (22) with a percentage of (22.7%) , while the number of employees who agree with it is (45) with a percentage of (46.4%) , and the number of employee who they disagree with it is (30) with a percentage of (30.9%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.43
Frequency distribution of question (32)

Answer	Number	Percentage
Strongly Agree	22	22.7%
Agree	45	46.4%
Disagree	30	30.9%
Strongly Disagree	0	0%
Total	97	100%

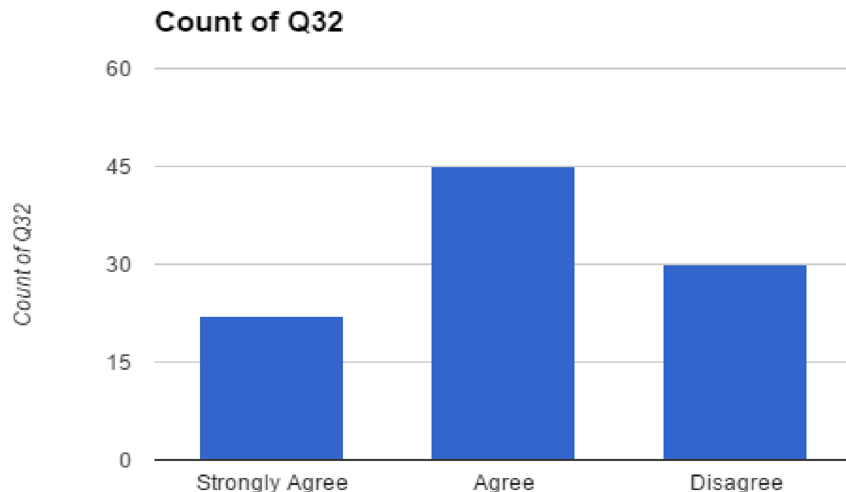


Fig. 4.38
Frequency distribution of question (32)

Key informant answers to Question (33) "Determining scheduled maintenance intervals using computer models will help in choosing the correct actions."

The frequencies and the percentage of the answers for this question were as shown in table (4.44) and figure (4.39), which show that the number of employees who they strongly agree with it is (24) with a percentage of (24.7%) , while the number of employees who agree with it is (37) with a percentage of (38.1%) , and the number of employee who

they disagree with it is (36) with a percentage of (37.1%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.44
Frequency distribution of question (33)

Answer	**Number**	**Percentage**
Strongly Agree	24	24.7%
Agree	37	38.1%
Disagree	36	37.1%
Strongly Disagree	0	0%
Total	97	100%

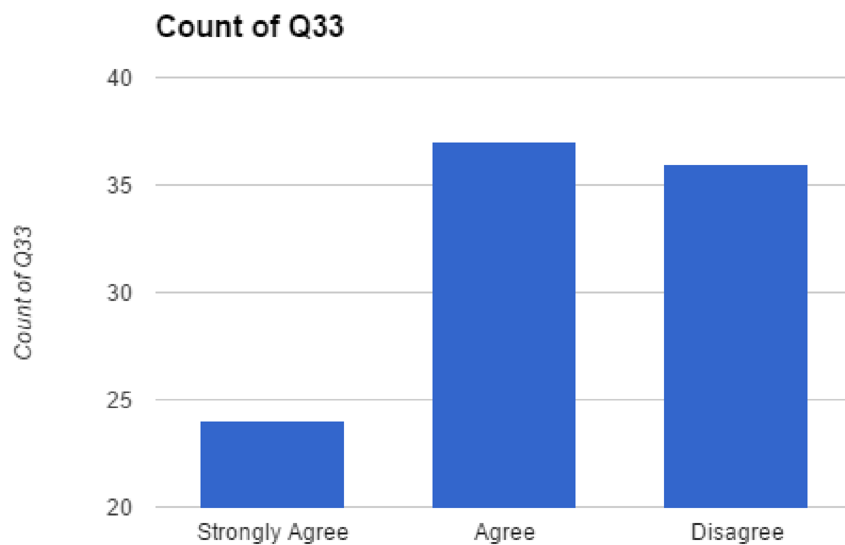


Fig. 4.39
Frequency distribution of question (33)

Key informant answers to Question (34) "Using computer software will accurate the Costing maintenance jobs process."

The frequencies and the percentage of the answers for this question were as shown in table (4.45) and figure (4.40), which show that the number of employees who they strongly agree with it is (15) with a percentage of (15.5%) , while the number of employees who agree with it is (62) with a percentage of (63.9%) , and the number of employee who they disagree with it is (20) with a percentage of (20.6%) , and the number of employee who they strongly disagree with it is (0) with a percentage of (0%).

Table 4.45
Frequency distribution of question (34)

Answer	Number	Percentage
Strongly Agree	15	15.5%
Agree	62	63.9%
Disagree	20	20.6%
Strongly Disagree	0	0%
Total	97	100%

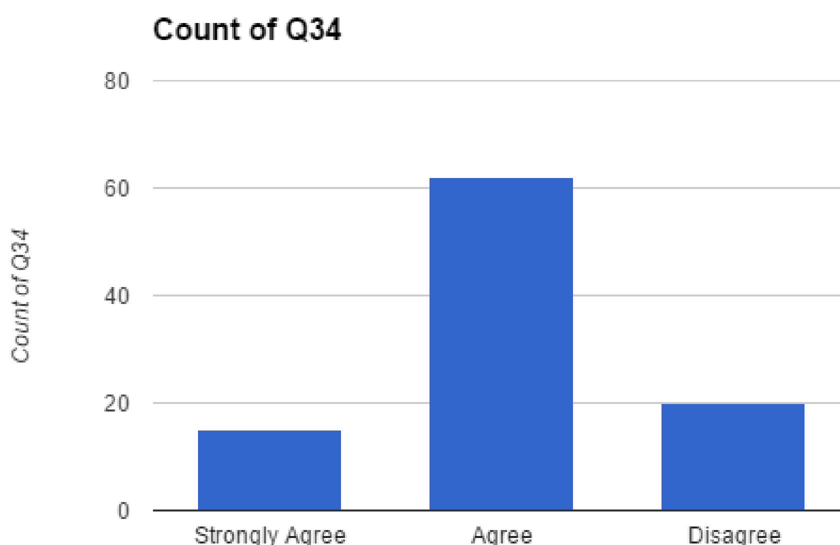


Fig. 4.40
Frequency distribution of question (34)

Key informant answers to Question (35) "Dispatching maintenance jobs on priority basis will improve maintenance functions."

The frequencies and the percentage of the answers for this question were as shown in table (4.46) and figure (4.41), which show that the number of employees who they strongly agree with it is (29) with a percentage of (29.9%) , while the number of employees who agree with it is (53) with a percentage of (54.6%) , and the number of employee who they disagree with it is (14) with a percentage of (14.4%) , and the number of employee who they strongly disagree with it is (1) with a percentage of (1%).

Table 4.46
Frequency distribution of question (35)

Answer	Number	Percentage
Strongly Agree	29	29.9%
Agree	53	54.6%
Disagree	14	14.4%
Strongly Disagree	1	1.0%
Total	97	100%

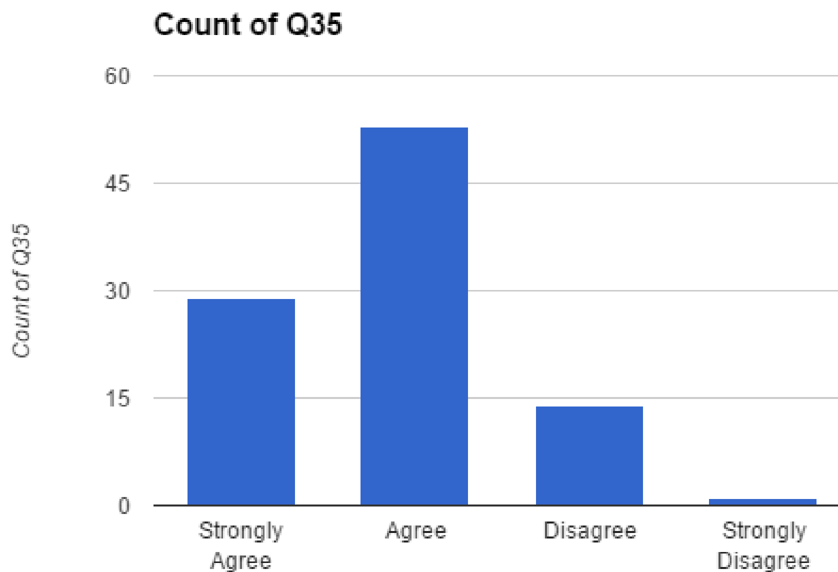


Fig. 4.41
Frequency distribution of question (35)

Key informant answers to Question (36) “Using computer will make it easy to store the maintenance reports and easy to review them.”

The frequencies and the percentage of the answers for this question were as shown in table (4.47) and figure (4.42), which show that the number of employees who they strongly agree with it is (25) with a percentage of (25.8%) , while the number of employees who agree with it is (37) with a percentage of (38.1%) , and the number of employee who they disagree with it is (34) with a percentage of (35.1%) , and the number of employee who they strongly disagree with it is (1) with a percentage of (1%).

Table 4.47
Frequency distribution of question (36)

Answer	Number	Percentage
Strongly Agree	25	25.8%
Agree	37	38.1%
Disagree	34	35.1%
Strongly Disagree	1	1.0%
Total	97	100%

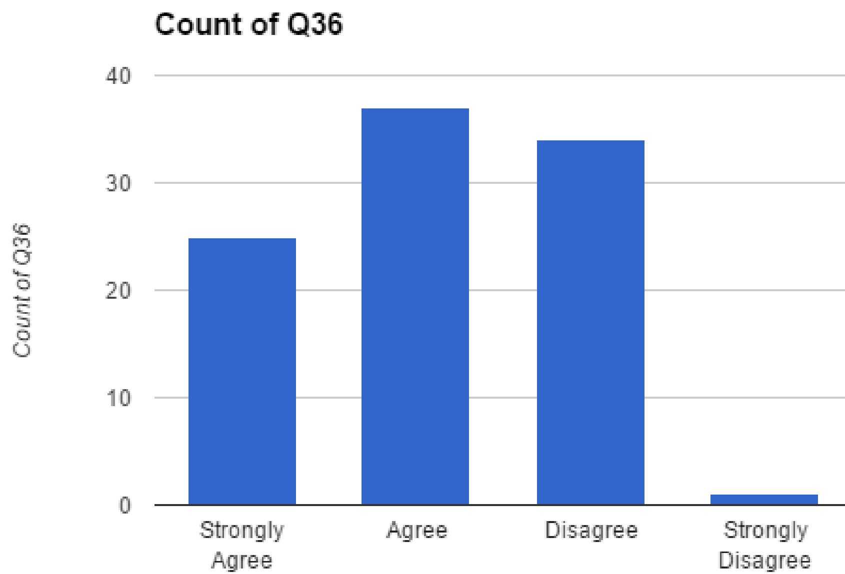


Fig. 4.42
Frequency distribution of question (36)

Key informant answers to Question (37) "Using Computer software rather than the paper job order will reduce the preparing time for maintenance."

The frequencies and the percentage of the answers for this question were as shown in table (4.48) and figure (4.43), which show that the number of employees who they strongly agree with it is (19) with a percentage of (19.6%) , while the number of employees who agree with it is (40) with a percentage of (41.2%) , and the number of employee who they disagree with it is (27) with a percentage of (27.8%) , and the number of employee who they strongly disagree with it is (11) with a percentage of (11.3%).

Table 4.48
Frequency distribution of question (37)

Answer	Number	Percentage
Strongly Agree	19	19.6%
Agree	40	41.2%
Disagree	27	27.8%
Strongly Disagree	11	11.3%
Total	97	100%

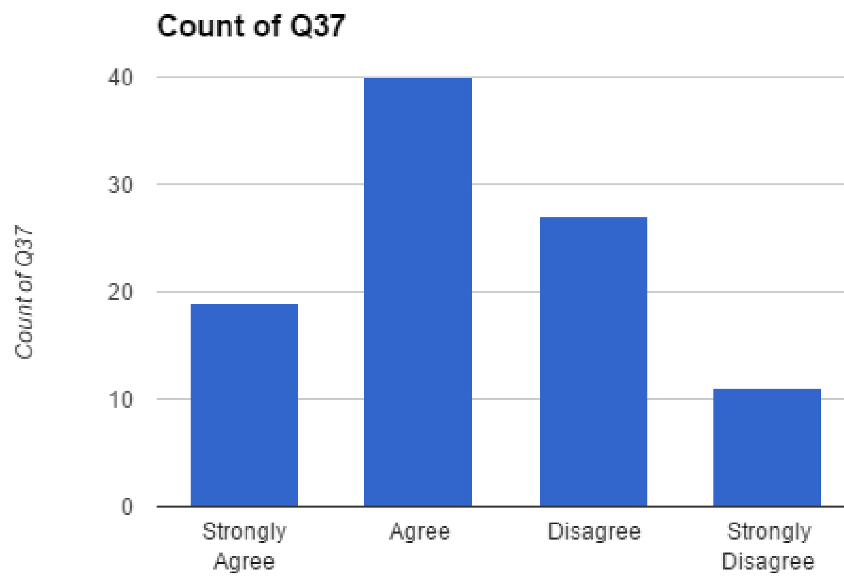


Fig. 4.43
Frequency distribution of question (37)

Table 4.49
Results of T-test to know the impact of applying communication-oriented PCIS on the preventive maintenance

NO.	Statement	Mean	Standard Deviation	Level based on Mean	T - value	Statistical significance
32	Performing maintenance tasks based on statistical modeling of failure data will improve maintenance efficiency	2.9175	0.73130	Medium	12.357	0.000
33	Determining scheduled maintenance intervals using computer models will help in choosing the correct actions	2.8763	0.78073	Medium	11.054	0.000
34	Using computer software will accurate the Costing maintenance jobs process	2.9485	0.60158	Medium	15.528	0.000
35	Dispatching maintenance jobs on priority basis will improve maintenance functions	3.1340	0.68661	High	16.267	0.000
36	Using computer will make it easy to store the maintenance reports and easy to review them	2.8866	0.80203	Medium	10.887	0.000
37	Using Computer software rather than the paper job order will reduce the preparing time for maintenance	2.6907	0.91698	Medium	7.419	0.000
	Total field	**2.9676**	**0.76742**	**Medium**	**12.159**	0.000

Table (4.49) clearly shows that the general arithmetic average of sample answers on the paragraphs that measure the impact of applying communication-oriented PCIS on the preventive maintenance, has reached (2.9676) with a standard deviation of (0.76742) which represents a medium degree of estimation, as all the paragraphs in the table benediction a high and medium estimates, and its supported by the values of (t) calculated function is statistically significant at the level of significance ($\alpha \leq 0.05$). Which requires a rejection of the first study hypothesis in their nihilism image and acceptance of alternative hypothesis, which states: There is a statistically significant effect at the level of significance ($\alpha \leq 0.05$) for applying communication-oriented PCIS t on the preventive maintenance.

Table 4.50
Impact mean of TQM and COPICS

Maintenance type	Impact Mean	
	TQM	COPICS
Corrective	**2.9140**	**3.0445**
Predictive	**2.9811**	**2.7182**
Preventive	**2.9676**	**2.9676**

Table (4.50) shows the impact mean of total quality management and communication-oriented production information and control system on the maintenance types. By comparing the results COPICS has more impact on the corrective maintenance than the TQM, and TQM has more impact on the predictive maintenance than COPICS while they have the same impact on the preventive maintenance.

4.3 Conclusions

From the study the following conclusions can be summarized:

1- Using tools of TQM Cause and Effect, Fishbone and Ishikawa Diagram help to find the root causes of the problems which will improve the maintenance performance.
2- Using COPICS Modules to Record the poor quality rate of equipment will avoid any unexpected failure which will improve the corrective maintenance performance.
3- Determining the needed spare parts by COPICS modules will reduce the repairing time.
4- Using Electronic schemes will make it easy to track the problem which will reduce the interruption time.
5- Using the Tool of TQM "Checklist" will improve the predictive maintenance performance by reducing the human Errors while doing the Predictive maintenance.
6- Using COPICS to provide failure historical data to predict where and when failure will happen will reduce the time required to repair the faults.
7- Using COPICS modules to monitor and control of machines will improve the performance of maintenance by reducing the interruption time.
8- Using COPICS modules to simulations will improve maintenance performance by predicting the failure before it happen.

9- Using the TQM principle of employees involving by involving technical Employee in the preventive maintenance planning process will improve the maintenance activities.
10- Using COPICS modules for performing maintenance tasks based on statistical modeling of failure data will improve maintenance efficiency.
11- Using COPICS modules determining scheduled maintenance intervals using computer models will help in choosing the correct actions.
12- Using COPICS modules will make it easy to store the maintenance reports and easy to review them.
13- Using COPICS modules rather than the paper job order will reduce the preparing time for maintenance.
14- There is a strongly agreement from the technical employees about that Involving Technical Employee in the preventive maintenance planning process will improve the maintenance activities, while the section heads and managers disagree with it.

4.4 Recommendations

Some of the recommendations that will help to improve the maintenance of electrical utilities in the national electric power company:

1- Working to raise the awareness of the total quality management importance in the maintenance departments in the company.
2- The worker in the maintenance departments should be educated on the total quality management and their principles.
3- The worker in the maintenance departments should be educated on the communication-oriented information and control systems and their models.
4- Applying the total quality management philosophy in the other departments in the national electric power company.
5- Applying communication-oriented production information and control system in the other departments in the national electric power company.
6- Train the employees of maintenance departments on the using of the communication-oriented production information and control systems.
7- Research in the other production management techniques and try to apply it in the maintenance departments in the national electrical power company such as Kanban, kaizen and just in time.
8- Create a developed and an effective system to measure maintenance performance and correct deviations that will happen.

4.5 Limitations

This research faced the following limitations:

1- The lack of the information that the employees have about the production management techniques in general.
2- The lack of the information that the employees have about the total quality management and there principles.
3- The lack of the information that the employees have about the communication-oriented information and control system and their modules.

4.6 Future Works

The following future work can be suggested:

1- Application of total quality management and communication-oriented production information and control system in other departments in national electrical power company.
2- Application of other production management techniques such as just in time, quality function deployment and kanpan in the maintenance departments in national electrical power company.
3- Increase the researches on total quality management and communication-oriented production information and control system.

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Appendix (I)
Questionnaire
(English)

This study examines the impact of applying production management Techniques on the maintenance of electrical utilities in the national electric power company. Two techniques where chosen, and they are: Total Quality Management (TQM) and Communication-Oriented production information control system (COPICS).

Total Quality Management is one from the modern management methods that aims to improve and develop the performance continuously by concentrate on the customers needed and it an integrated systems by it we grouped various units within the plant or facility that works in the areas of quality improvement and production products to ensure an appropriate degree of quality development will satisfy the desires of the consumer and at the lowest cost.

Communication-oriented production information control system is mode units, each unit carrying out an independent package of applications and all packets connected with each bite through databases, and from these units: Planning and predicted inventory, the controller and control facility, Unit facilities data management and planning Unit required materials.

Please choose the right choice for each statement from the following statements by putting (X) in their square:

First Part: Personal Information

1-	Gender	☐ Male	☐ Female
2-	Age	☐ less than 25 ☐ 35 – 45	☐ 25 -35 ☐ More than 45
3-	Qualification	☐ Secondary ☐ Bachelor ☐ Ph.D.	☐ Diploma ☐ Master ☐ Other
4-	Job Title	☐ Technical ☐ Engineer ☐ Dep. Manager	☐ Supervisor ☐ Section Head ☐ Other
5-	Experience years	☐ less than 5 ☐ 10-15	☐ 5-10 ☐ More than 15
6-	Department	☐ Substations ☐ Electromechanical ☐ Other	☐ Transmission Lines ☐ Protection

Second Part: Statements of the questionnaire

NO.	Statement	The Degree Of Approval			
		Strongly Agree	Agree	Disagree	Strongly Disagree
I-	Impact of Apply TQM on The Corrective Maintenance				
Q1	Using tools of TQM Cause and Effect, Fishbone and Ishikawa Diagram help to find the root causes of the problems				
Q2	Records kept for future decision making will help in dealing with similar events				
Q3	Adequate ventilation, first aid and Personal Protective items should be available.				
Q4	Frequency of corrective operation (rework) should be noted as performance index				
Q5	Delegation of responsibility is essential for over or overall operation success.				
Q6	Quality assurance team should be formulated.				
II-	Impact of Apply COPICS on The Corrective Maintenance				
Q7	Recording the poor quality rate of equipment will avoid any unexpected failure				
Q8	Estimating the time of repairing works will reduce the unsold power				
Q9	determining the needed spare parts will reduce the repairing time				
Q10	Computer software helps in measuring of Maintenance System performance				
Q11	Publish Laws and rules of maintenance on local network will make it easy access for the employee				
Q12	Using Electronic schemes will make it easy to track the problem which will reduce the interruption time				

NO.	Statement	The degree of approval			
		Strongly Agree	Agree	Disagree	Strongly Disagree
III- Impact of Apply TQM on The Predictive Maintenance					
Q13	Using the Tool of TQM "Checklist" will reduce the human Errors while doing the Predictive maintenance				
Q14	To ensure clients demand and high quality standards, the supplied materials are examined before installation				
Q15	Periodic measurement of maintenance quality management must be done				
Q16	Conventional method of detecting faults should be in place				
Q17	Personnel should be taught fault recognition techniques				
Q18	Period retrospective check on successful implementation essential.				
IV- Impact of Apply COPICS on The Predictive Maintenance					
Q19	provides failure historical data to predict where and when failure will happen will reduce interrupting time				
Q20	Equipment downtime is tracked and reviewed periodically will improve the maintenance efficiency				
Q21	Monitoring and controlling of machines will reduce the interruption time				
Q22	Computer software will help in finding the data of every unit or equipment				
Q23	Applying life cycle curves to modify long range projections and improve the maintenance activities				
Q24	Using software simulations will help to predict the failure before it happen				

NO.	Statement	The degree of approval			
		Strongly Agree	Agree	Disagree	Strongly Disagree
V-	Impact of Apply TQM on The Preventive Maintenance				
Q25	Using the Tool of TQM "Checklist" will reduce the human Errors while doing the preventive maintenance				
Q26	Involving Technical Employee in the preventive maintenance planning process will improve the maintenance activities				
Q27	Standard of works and operational quality should be clearly communicated				
Q28	Management should convey meeting on quality in maintenance issue periodically.				
Q29	There should be budget for preventive maintenance.				
Q30	The maintenance time should be Suitable for the customers				
Q31	The company should have plan for the preventive maintenance over the year				
VI-	Impact of Apply COPICS on The Preventive Maintenance				
Q32	Performing maintenance tasks based on statistical modeling of failure data will improve maintenance efficiency				
Q33	Determining scheduled maintenance intervals using computer models will help in choosing the correct actions				
Q34	Using computer software will accurate the Costing maintenance jobs process				
Q35	Dispatching maintenance jobs on priority basis will improve maintenance functions				
Q36	Using computer will make it easy to store the maintenance reports and easy to review them				
Q37	Using Computer software rather than the paper job order will reduce the preparing time for maintenance				

Appendix (II)
Questionnaire
(Arabic)

هذه الدراسة تبحث في أثر تطبيق تقنيات إدارة الإنتاج على أداء الصيانة في شركة الكهرباء الوطنية و تم التركيز على تقنيتين و هما : تقنية إدارة الجودة الشاملة (TQM) و تقنية نظام التحكم و معلومات الإنتاج الموجهة بالحاسوب (COPICS).

إدارة الجودة الشاملة (TQM) من أساليب الإدارة الحديثة التي تهدف إلى تحسين و تطوير الأداء بشكل مستمر و ذلك من خلال التركيز على متطلبات العميل و هي عبارة عن نظام شامل و متكامل بواسطته يمكن تجميع عمل الوحدات المختلفة داخل المصنع أو المنشأة التي تعمل في مجالات تطوير الجودة و تحسينها لضمان إنتاج المنتجات بدرجة مناسبة من الجودة ترضي رغبات المستهلك و بأقل التكاليف.

نظام التحكم و معلومات الإنتاج الموجهة بالحاسوب هو اسلوب وحدات كل وحدة تقوم بتنفيذ حزمة مستقلة من التطبيقات وجميع الحزم متصل مع بعضها العض من خلال قواعد البيانات ، و من هذه الوحدات : وحدة تخطيط و توقع المخزون، وحدة تحكم و مراقبة المنشأة، وحدة إدارة بيانات المرافق و وحدة تخطيط المواد المطلوبة.

الرجاء اختيار الاجابة المناسبة لكل عبارة من العبارات التالية و ذلك بوضع اشارة (X) في المربع الذي يشير اليها :

الجزء الأول: المعلومات الشخصية

1- النوع الاجتماعي	ذكر ☐	أنثى ☐
2- العمر	أقل من 25 ☐	35-25 ☐
	45-35 ☐	أكبر من 45 ☐
3- المؤهل العلمي	ثانوي ☐	دبلوم ☐
	جامعي ☐	ماجستير ☐
	دكتوراه ☐	
4- المسمى الوظيفي	فني ☐	مراقب ☐
	مهندس ☐	رئيس قسم ☐
	مدير دائرة ☐	أخرى ☐
5- عدد سنوات الخبرة	أقل من 5 ☐	10 - 5 ☐
	15 - 10 ☐	أكثر من 15 ☐
6- الدائرة	المحطات ☐	الخطوط ☐
	الوقاية ☐	الكهروميكانيك ☐
	أخرى ☐	

الجزء الثاني: عبارات الإستبانة

الرقم	العبارة	درجة الموافقة / عدم الموافقة			
		موافق بشدة	موافق	غير موافق	غير موافق بشدة
I-	أثر تطبيق إدارة الجودة الشاملة (TQM) على الصيانة التصحيحية (CM)				
س1	إستخدام أدوات إدارة الجودة الشاملة- السبب والنتيجة، وهيكل السمكة مخطط إيشيكاوا- يساعدة في العثور على الأسباب الجذرية للمشاكل				
س2	السجلات المحفوظة لاتخاذ القرارات في المستقبل تساعد في التعامل مع أحداث مماثلة				
س3	التهوية الكافية، والإسعافات الأولية والمواد الواقية الشخصية ينبغي أن تكون متاحة.				
س4	يجب اعتماد عملية تكرار الأعمال التصحيحية (إعادة العمل) كمؤشر آداء للصيانة				
س5	منح الصلاحيات ضروري لنجاح عملية الصيانة التصحيحية بشكل عام.				
س6	يجب أن يشكل فريق ضمان الجودة لضمان جودة الصيانة التصحيحية				
II-	أثر نظام التحكم و معلومات الإنتاج الموجهة بالحاسوب (COPICS) على الصيانة التصحيحية (CM)				
س7	تسجيل معدل ضعف الجودة للمعدات يساعد في تفادي أي فشل غير متوقع				
س8	تقدير مدة أعمال الصيانة التصحيحية يؤدي إلى تقليل الطاقة الغير المباعة				
س9	تحديد قطع الغيار اللازمة يؤدي إلى تقليل وقت إصلاح المعدات				
س10	تساعد برامج الحاسوب في قياس أداء الصيانة التصحيحية				
س11	نشر قوانين و قواعد الصيانة على الشبكة الداخلية سيجعل من السهل الوصول اليها من قبل الموظف				
س12	إستخدام المخططات الإلكترونية يسهل تتبع المشكلة وبالتالي سوف تقلل من فترة الانقطاع				
III-	أثر تطبيق إدارة الجودة الشاملة (TQM) على الصيانة التنبؤية (PdM)				
س13	إستخدام أداة إدارة الجودة الشاملة "قائمة التدقيق" سوف يقلل من الأخطاء البشرية أثناء القيام بالصيانة التنبؤية				
س14	يتم فحص المواد الموردة قبل التثبيت لضمان مطالب العملاء ومعايير الجودة العالية				
س15	يجب أن يتم قياس دوري لإدارة جودة الصيانة التنبؤية				
س16	يجب إستبدال الطريقة التقليدية للكشف عن أخطاء				
س17	يجب تعليم موظفي الصيانة تقنيات التعرف على الأخطاء				
س18	يجب توافر فحص مستمر لنجاح أساسية التنفيذ				

الرقم	العبارة	موافق بشدة	موافق	غير موافق	غير موافق بشدة
		درجة الموافقة / عدم الموافقة			
IV-	أثر نظام التحكم و معلومات الإنتاج الموجهة بالحاسوب (COPICS) على الصيانة التنبؤية (PdM)				
س19	يساعد توفر البيانات التاريخية للأعطال السابقة في التنبؤ أين ومتى سيحدث العطل و بالتالي سيقلل من وقت الإنقطاع				
س20	متابعة تعطل المعدات ومراجعتها بشكل دوري من شأنه تحسين كفاءة الصيانة				
س21	مراقبة الآلات و المعدات تساعد على تقليل فترة الإنقطاع				
س22	برامج الحاسوب تساعد في العثور على البيانات الخاصة بكل معدة بسهولة				
س23	تطبيق منحنيات دورة الحياة لتعديل التوقعات طويلة المدى يساعد في تحسين أنشطة الصيانة التنبؤية				
س24	استخدام برامج المحاكاة تساعد على التنبؤ بالعطل قبل أن يحدث				
V-	أثر تطبيق إدارة الجودة الشاملة (TQM) على الصيانة الوقائية (PvM)				
س25	إستخدام أداة إدارة الجودة الشاملة "قائمة التدقيق" سوف يقلل من الأخطاء البشرية أثناء القيام بالصيانة الوقائية				
س26	إشراك الفنيين في عملية التخطيط للصيانة الوقائية سيؤدي إلى تحسين أنشطة الصيانة الوقائية				
س27	مستوى أعمال الصيانة الوقائية والجودة التشغيلية يجب أن تبلغ بوضوح				
س28	عقد الإدارة لقاءات عن دور الجودة في قضية صيانة الوقائية سيحسن من آداء الصيانة الوقائية				
س29	يجب أن تكون هناك ميزانية محددة للصيانة الوقائية				
س30	يجب أن يكون وقت الصيانة الوقائية مناسباً للعملاء في المقام الاول				
س31	يجب أن يكون للشركة خطة للصيانة الوقائية خلال العام				
VI-	أثر نظام التحكم و معلومات الإنتاج الموجهة بالحاسوب (COPICS) على الصيانة الوقائية (PvM)				
س32	تنفيذ مهام الصيانة على أساس النمذجة الإحصائية لبيانات الأعطال السابقة سيؤدي إلى تحسين كفاءة الصيانة الوقائية				
س33	تحديد فترات الصيانة المبرمجة باستخدام نماذج حاسوبية يساعد في اختيار الوقت الأمثل لإجراء الصيانة الوقائية				
س34	استخدام برمجيات الحاسوب سيساعد في حساب تكلفة عملية الصيانة بشكل أدق				
س35	إنتقاء عمليات الصيانة على أسس الأولوية سيؤدي إلى تحسين وظائف الصيانة الوقائية				
س36	استخدام الحاسوب سوف يجعل من السهل عملية تخزين تقارير الصيانة و تسهيل إعادة استرجاعها				
س37	استخدام برامج الحاسوب بدلا من النماذج الورقية سيؤدي إلى تقليل وقت التحضير للصيانة الوقائية				

المعلومات الشخصية

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